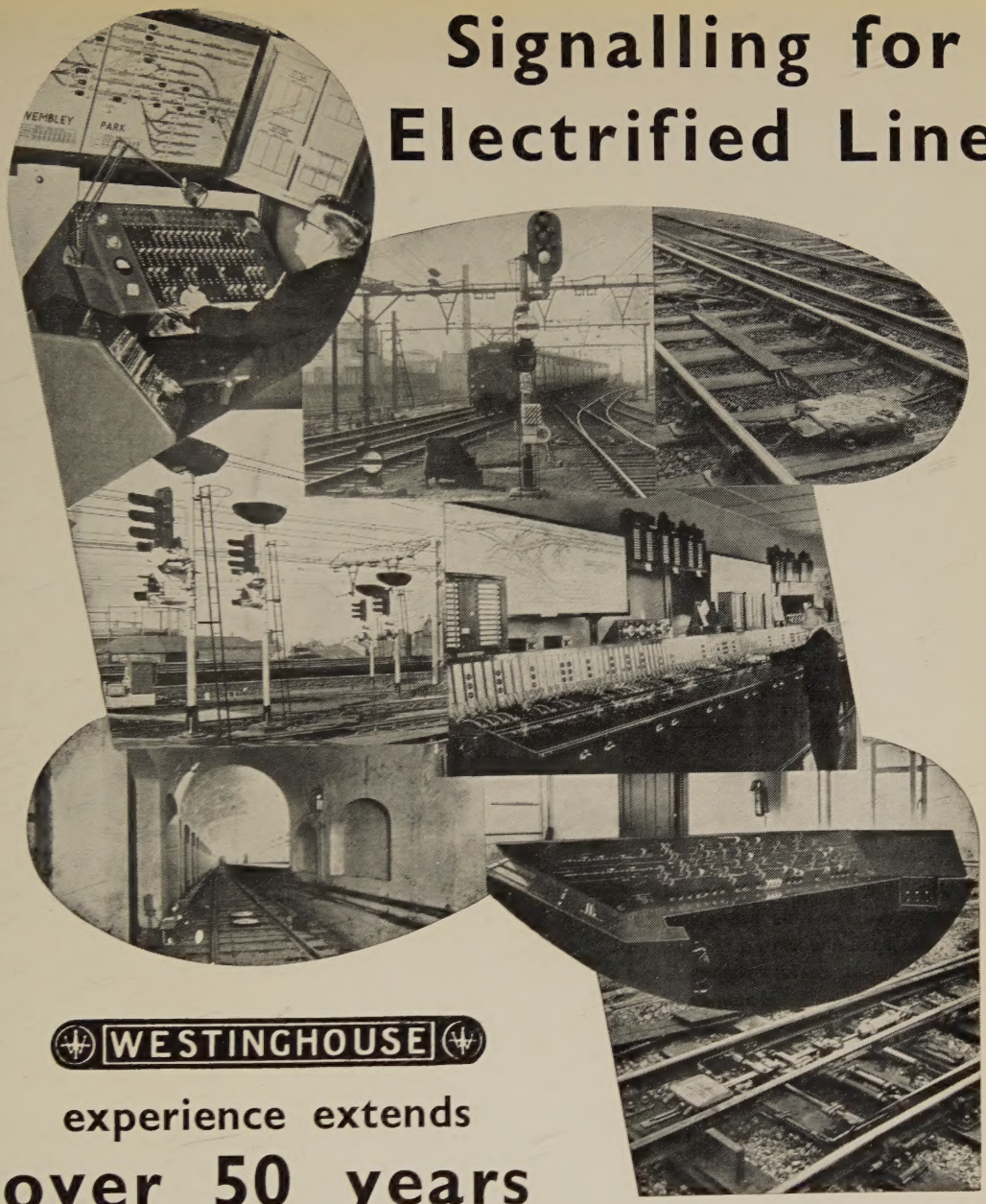
VOL. XXXIII. — No. 2. FEBRUARY 1956.

Monthly Bulletin of the International Railway Congress Association

(English Edition)

THE LIBRARY OF THE
APR 4 1956
UNIVERSITY OF ILLINOIS

Signalling for Electrified Lines



WESTINGHOUSE

experience extends over 50 years

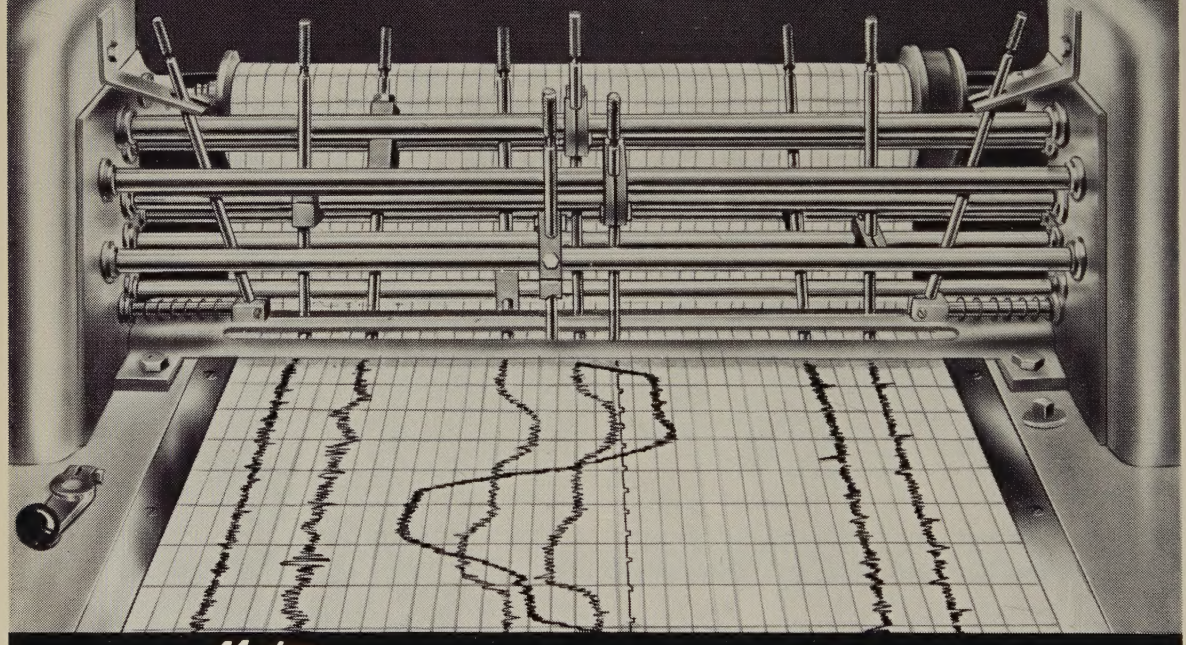
From the early days of London's Underground Electric Railways to the present day when Westinghouse ELECTRIC and ELECTRO-PNEUMATIC signal equipment is now extensively used in many of the World's most important electrified schemes both old and new.

LONDON TRANSPORT - SOUTHERN REGION
EASTERN REGION
MANCHESTER—SHEFFIELD—WATH
LACROZE SUBWAY (Buenos Aires)
LIVERPOOL OVERHEAD - MERSEY
BOMBAY (CENTRAL AND WESTERN RAILWAYS)
(Formerly G.I.P. B.B. & C.I.R.)
ESTRADA FERRO SANTOS A JUNDIAI
(Formerly San Paulo Railway)

Westinghouse Brake & Signal Co. Ltd., 82, York Way, Kings Cross, London, N.1

Matisa

TRACK RECORDING TROLLEY



The Matisa Track Recording Trolley is a self-propelled vehicle, capable of travelling at a speed of about 30 m.p.h. It records, to within accuracies of 1 mm.(0,39") the exact geometric condition of the track **under load,** thus allowing maintenance tasks to be programmed. From these records, accurate check is made of the quality of maintenance work carried out and the efficiency of maintenance methods is revealed, thus effecting considerable all-round economy.

Matisa

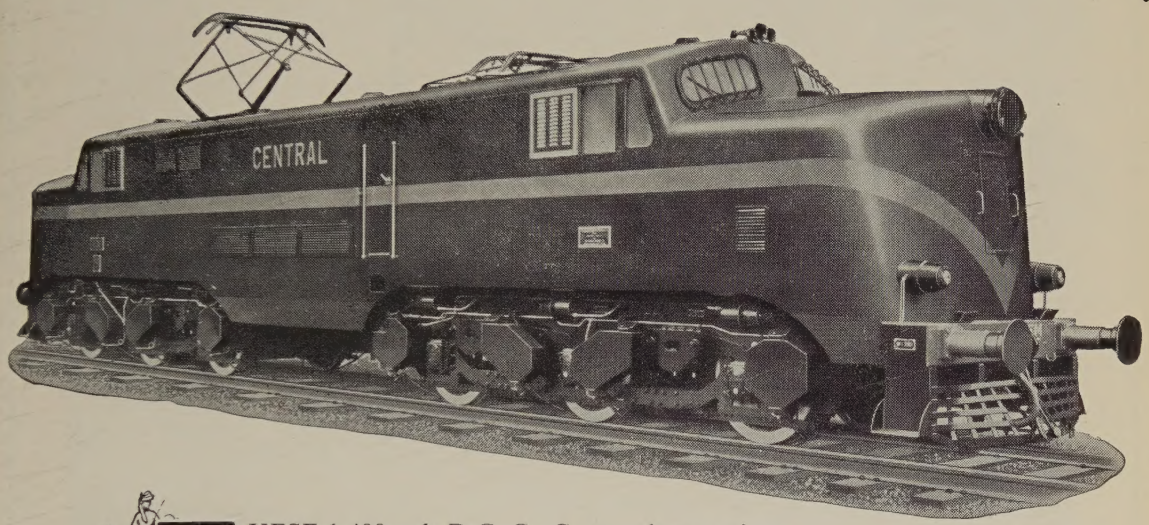
track maintenance specialists all over the world

GRAND PONT 2, LAUSANNE, SWITZERLAND.
SUPPLIERS FOR THE BRITISH COMMONWEALTH
MATISA EQUIPMENT Ltd. 78, BUCKINGHAM GATE, LONDON, S. W. 1.

ILLUSTRATED TECHNICAL LITERATURE ON REQUEST

M/10-5 A

3,600 h.p. electric locomotives for India



THESE 1,400 volt D.C. Co-Co type locomotives ordered by the Central Railway of India are for high speed passenger and heavy freight haulage on the Bombay-Poona and Bombay-Igatpuri sections, where long gradients of 1 in 37 are encountered.

The locomotives weigh 122 tons and have a maximum axle load of 20½ tons. The mechanical parts are built by The Vulcan Foundry Limited, a member of the 'ENGLISH ELECTRIC' Group of Companies.

'ENGLISH ELECTRIC'

electric traction

Generating Plant — Steam, Hydraulic, Gas Turbine or Diesel. Transformers, Rectifiers, Switchgear and Fusegear. Industrial Electrification. Electric and Diesel-electric Traction. Marine Propulsion and Auxiliaries. Aircraft. Aircraft Equipment. Guided Missiles. Industrial Electronic Equipment. Instruments. Domestic Electrical Appliances. Television Receivers.

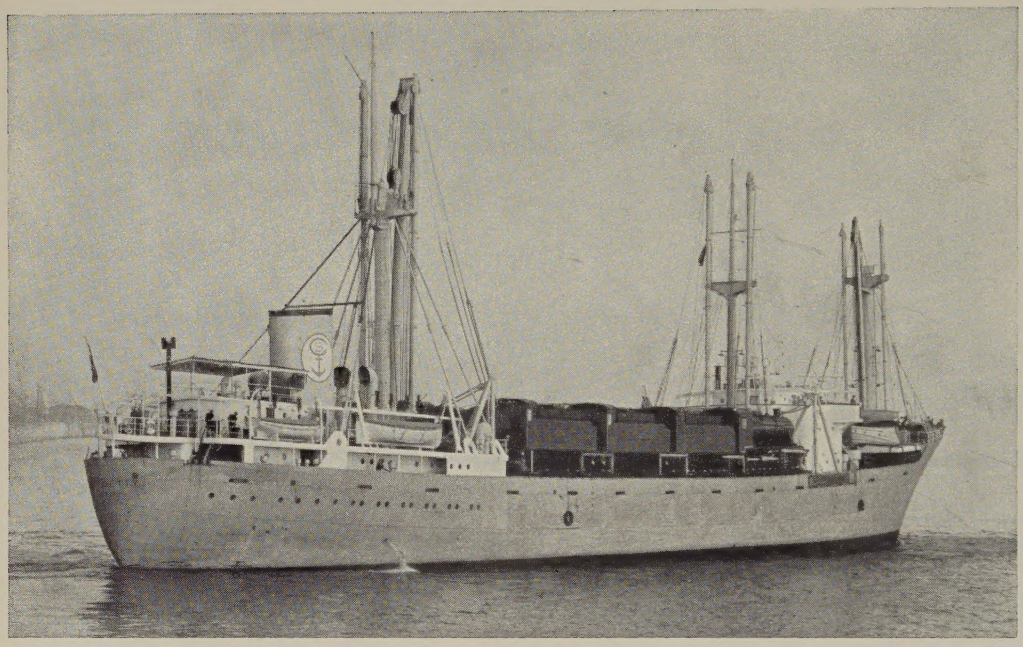
THE ENGLISH ELECTRIC COMPANY LIMITED, QUEENS HOUSE, KINGSWAY, LONDON, W.C.2

Offices and representatives throughout the world

TDE. 30 E

BELSHIPS COMPANY LTD. SKIBS A/S

Managers : CHRISTEN SMITH & CO., OSLO *Telegrams :* CHRISSMITH-OSLO



"Belbetty" carrying a cargo of locomotives and tenders for the Egyptian State Railways

- Special ships for heavy-lift transportation
- Derricks capable of lifting up to 200 tons
- Transport to any part of the world
- Delivery of railway units ready for immediate service

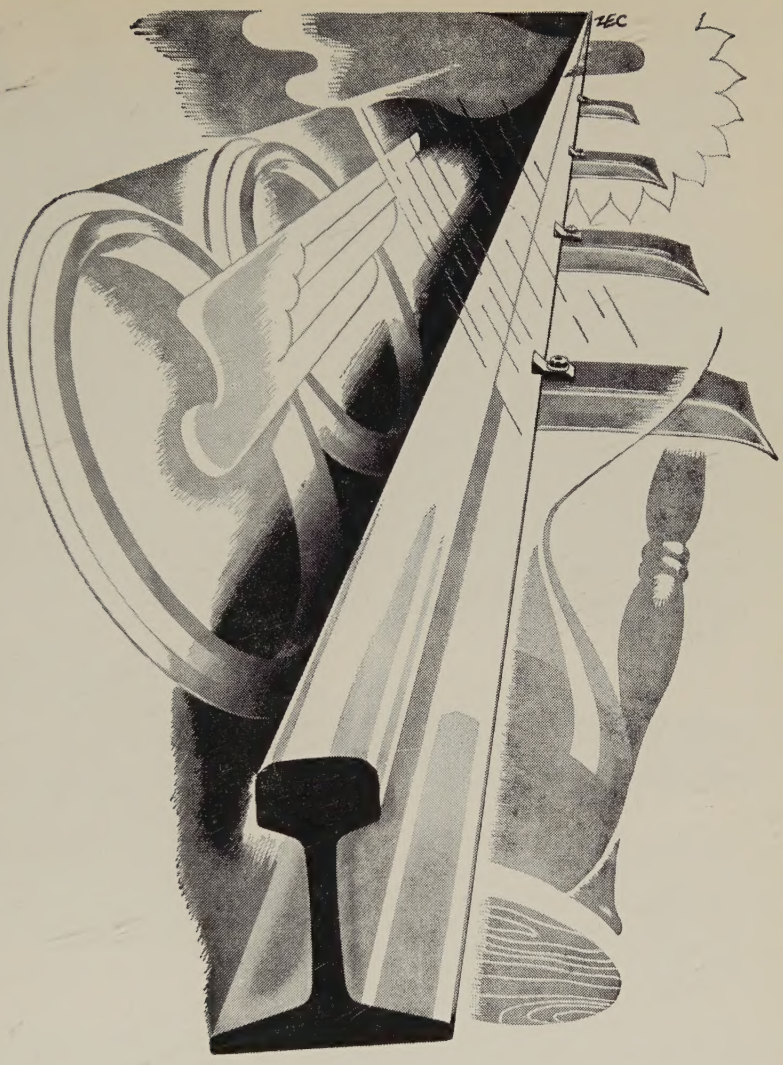
●

AGENTS :

BELSHIPS COMPANY LIMITED

39 VICTORIA STREET, LONDON S.W.1

Phone : ABBey 6477 *Telegrams : BELSHIPS, SOWEST, LONDON*



RAILWAY MATERIALS

Rails are made at Workington by the acid Bessemer Process, of which the long-wearing properties have long been appreciated by railway engineers in many countries. The Workington plant also manufactures fishplates, soleplates and steel sleepers.

Our Steel Peech & Tozer works produces railway tyres, which can also be supplied in heat-treated form, disc wheel centres and solid wheels; carriage, wagon and locomotive axles and laminated springs.

THE UNITED STEEL COMPANIES LTD

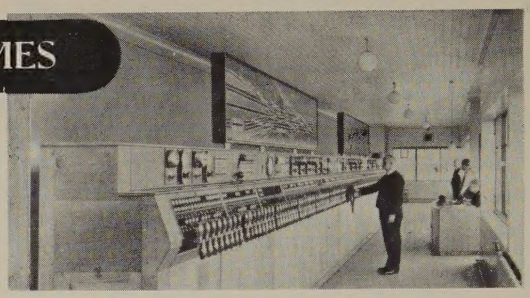
WORKINGTON IRON & STEEL COMPANY · WORKINGTON
STEEL PEECH & TOZER · THE ICKLES · SHEFFIELD

Branch of The United Steel Companies Limited of Sheffield, England

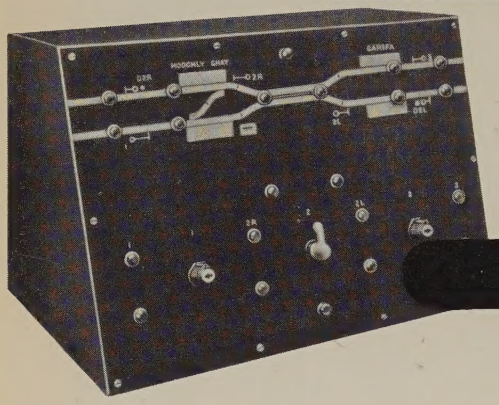
MV-GRS

POWER SIGNALLING

POWER FRAMES



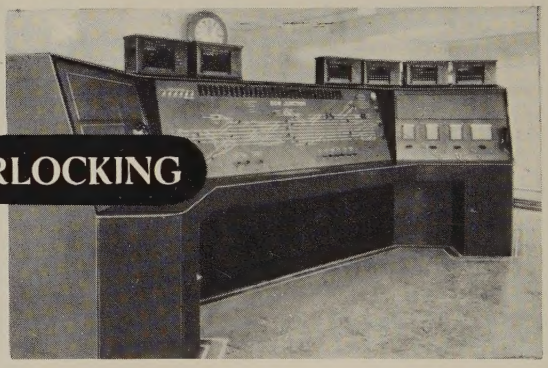
Bristol West Cabin—British Railways, Western Region, 328 levers



Panel at Hooghly Ghat, India

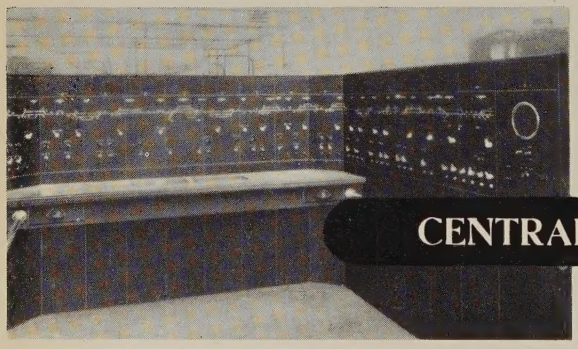
SIGNAL CONTROL PANELS

TYPE NX ROUTE RELAY INTERLOCKING



Bow Junction—British Railways, Eastern Region

CENTRALIZED TRAFFIC CONTROL



New Zealand Government Railways

The experience of MV-GRS engineers covers all aspects of railway signalling throughout the world The Company's technical resources and practical knowledge have enabled MV-GRS to pioneer many important advances in power signalling. The first plug-in detachable relays, for example, were introduced into service more than ten years ago by MV-GRS. Similarly, MV-GRS led the way in the development of signalling systems for outstanding marshalling yards such as Toton, L.M. Region. For future advances in railway signalling, from complete Centralised Control systems to point operating machines—look to MV-GRS. Please write for Publication SP.7601-1.

METROPOLITAN-VICKERS-GRS LIMITED, 132-135 LONG ACRE, LONDON, W.C.2.

MV-GRS *Signalling Equipment for Railways*

CROSSLEY

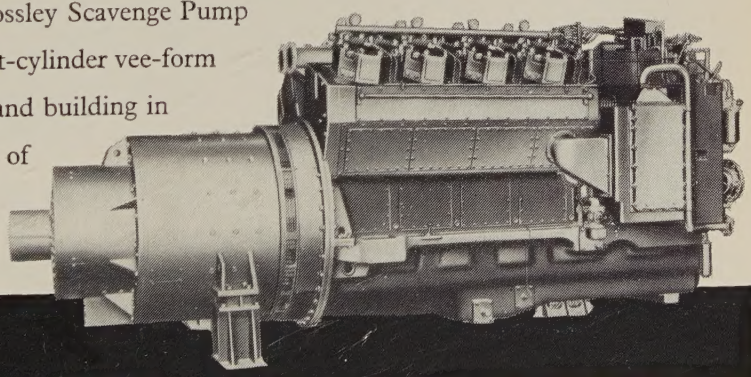
LOCOMOTIVE DIESEL ENGINES

48 Western Australian Government Railways

99 Coras Iompair Eireann

20 British Railways

Each of the 20 Metropolitan Vickers Type B diesel electric main line locomotives for British Railways will be powered by a 1200 B.H.P. Crossley Scavenge Pump Diesel Engine. This is the eight-cylinder vee-form unit of the type already built and building in large numbers for the railways of Western Australia and Eire.



ESTABLISHED 1866

CROSSLEY BROTHERS LIMITED · OPENSHAW · MANCHESTER 11

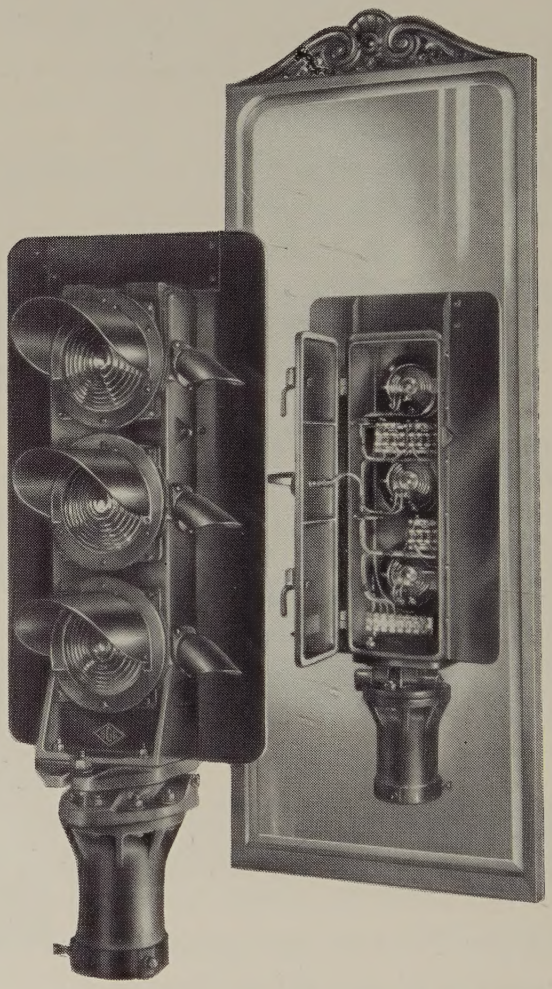
LONDON OFFICE: Langham House, 308 Regent Street, W.1.

Upon Reflection . . .

a good signal from every aspect

SGE

- Improved Light Beam.
- Wide visibility sidelight sector.
- Sidelight & backlight lamp units interchangeable.
- Transformers of intrinsic design, multi-tapped, B.S. markings.
- Adequate hand room for easy lamp changing.
- Robust high-duty alloy case.
- Built to accommodate Direction Route Indicator.
- Gasketted door with handles to clamp and padlock.
- Adjustable mounting and effective peepsight.
- O.B.A. Terminals & links for incoming cable termination.



TYPE LQ SIGNAL

SIDELIGHTS · BACKLIGHTS
TRANSFORMERS · HOODS
BACKGROUNDS · ASPECTS
& MOUNTINGS
all to suit
YOUR REQUIREMENTS

SGE SIGNALS

THE SIEMENS AND GENERAL ELECTRIC RAILWAY SIGNAL COMPANY LIMITED
EAST LANE, WEMBLEY, ENGLAND Tel: ARNold 4321 Grams & Cables: "Railsigko, Wembley"

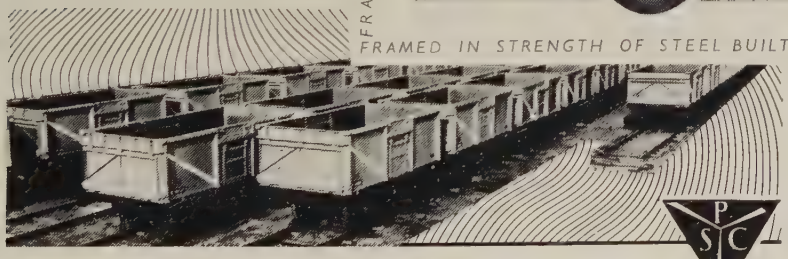
from strength to strength in steel

FRAMED IN STRENGTH OF STEEL BUILT FOR ENDURING SERVICE

For enduring service . . . the strength of steel. For design and construction, sound, steadfast and reliable . . . the immense facilities, the engineering experience, the craftsmanship of Pressed Steel Company Limited. Strength added to strength . . . reason enough why over 11,000 of these 16-ton mineral wagons will be Pressed Steel built to the order of British Railways annually. *Pressed Steel Company Limited also manufacture wagons and rolling stock for world railways.*

FRAMED IN STRENGTH OF STEEL BUILT FOR ENDURING SERVICE

FRAMED IN STRENGTH OF STEEL BUILT FOR ENDURING SERVICE



RAILWAY DIVISION
PAISLEY, SCOTLAND

HEAD OFFICE
COWLEY, OXFORD

wagons and rolling stock by

PRESSED STEEL COMPANY LIMITED

London Office: Sceptre House, 169 Regent Street, W.1

LA BRUGEOISE ET NICAISE & DELCUVE

LIMITED LIABILITY COMPANY

Steel-works, Forges and Engineering Works
Head-Office and General Direction at
St-Michel near Bruges

ALL ROLLING STOCK
AND FIXED EQUIPMENT FOR
RAILWAYS AND TRAMWAYS

BRIDGES, FRAMEWORKS, TANKS, GAS-HOLDERS AND ALL STEEL CONSTRUCTIONS RIVETED AND WELDED

●

WHEEL SETS — STEEL CASTINGS — IRON FOUNDRY
SPRINGS

STEEL, PEECH & TOZER
for RAILWAY MATERIALS

wherever there are railways

The Steel, Peech & Tozer plant produces tyres, disc wheel centres, solid wheels, finished wheel and axle sets, straight and crank axles and laminated springs for railway locomotives, carriages and wagons.
These products are known all over the world —'wherever there are railways'.

THE UNITED STEEL COMPANIES LTD

STEEL, PEECH & TOZER - THE ICKLES - SHEFFIELD, ENGLAND

Branch of The United Steel Companies Limited

Telegrams : 'Phoenix, Sheffield'

Telephone : Sheffield 41011 ; Rotherham 5421

ULTRASONIC TESTING OF WAGGON AXLES BY KRETZ

Now, that the principle of ultrasonic testing of waggon- and locomotive axles is generally accepted, this method asks for a reliable and accurate instrument which can be easily handled by a non-expert operator.

●

KRETZ

COMPANY

ZIPF (Austria)

●

≺ KRETZ' Supersonic apparatus Universal type, serie Nr 100

●

Outstanding features :

Portable;
Possibility to test with 1 or 2 test-probes;
Electronic magnifier:
Small testprobes with narrow homogeneous beam;
High frequencies up to 10 MCs.

As specialists **KRETZ** have created this ingenious ultrasonic apparatus, built to meet all these requirements. This fact has been acknowledged by a large number of railways all over the world.

Address: General exporters **LABIMEX** — Zandvoort (Holland)

Alphabetical Index of Advertisers

Firms :		Specialities :
Ateliers Métallurgiques (Les)	—	Railway rolling stock.
Belships Company Limited	IV	World-wide heavy-lift service.
Brugeoise et Nicaise & Delcuve	X	Railway rolling stock and fixed equipment.
Cockerill-Ougrée (S.A.)	—	Machinery and metal structures. Diesel-electric locomotives.
Crossley Brothers Ltd.	VII	Diesel locomotives.
English Electric Company Ltd (The)	III	Railway electrification.
General Electric Company Ltd of England	—	Electrical traction equipment.
Hasler (A.G.)	—	Speed indicators and recorders.
Kretz Company	XII	Ultrasonic testing of waggon axles.
Matisa Equipment Limited	II	Permanent way equipment.
Metalexport	—	Railway rolling stock.
Metropolitan-Cammell Carriage & Wagon C°. Ltd.	—	Lightweight railway coaches.
Metropolitan-Vickers-GRS Ltd.	VI	Signalling equipment for railways.
Pressed Steel Co Ltd.	IX	Wagons.
S.A.B. (Svenska Aktiebolaget Bromsregulator)	—	Automatic slack adjusters.
Siemens and General Electric Railway Signal Co. Ltd.	VIII	Signalling equipment.
S.K.F. (Société Belge des Roulements à Billes)	—	Axleboxes.
Superheater Company (The)	—	Superheaters for locomotives.
United Steel Companies, Ltd. (The)	V & XI	Railway materials.
Westinghouse Brake & Signal Co., Ltd.	I	Railway signalling. Brakes.

MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

PUBLISHING and EDITORIAL OFFICES : 19, RUE DU BEAU-SITE, BRUSSELS

Yearly subscription for 1956 : { **Belgium . . . . . 700 Belgian Francs** / **Universal Postal Union . . 800 Belgian Francs**

Price of this single copy : 80 Belgian Francs (not including postage).

Subscriptions and orders for single copies (January 1931 and later editions) to be addressed to the General Secretary, International Railway Congress Association, 19, rue du Beau-Site, Brussels (Belgium).

Orders for copies previous to January 1931 should be addressed to Messrs. Weissenbruch & Co. Ltd., Printers, 49, rue du Poinçon, Brussels.

Advertisements : All communications should be addressed to the Association, **19, rue du Beau-Site, Brussels.**

CONTENTS OF THE NUMBER FOR FEBRUARY 1956.

CONTENTS

Page.

I. **Research on the economic usefulness and the technical opportunity to install a third track, serving for common use (banalisation), in addition to sections of double track lines with heavy traffic, instead of installing two double track lines on such sections. Consequences of the installation of a third track for use in either direction on the conditions necessary to insure the safety of train movements.** (Question 1, Enlarged Meeting of the Permanent Commission, The Hague-Scheveningen, 1956) :
Report: *(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, Netherlands, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and dependent overseas territories)* by V.J.M. De Blieck 95

II. **Development of railway tariffs. Economic justification of these tariffs. Adjustment of tariffs to the new conditions of the general economic system and to the competition of the other forms of transport. Function of tariffs in coordination of inland transports.** (Question 3, Enlarged Meeting of the Permanent Commission, The Hague-Scheveningen, 1956) :
Report: *(Austria, Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Greece, Hungary, Italy, Lebanon, Luxemburg, Netherlands, Poland, Portugal and overseas territories, Rumania, Spain, Switzerland, Syria, Turkey and Yugoslavia)*, by L. Antoine . . 107

CONTENTS *(continued)*. Page.

III. **In a system of standard, narrow or broad gauge lines which has Diesel traction for shunting and for main line working, what are the conditions governing : 1) the choice of the characteristics and kind of transmission; 2) the most economical organisation, maintenance and operation. Research into savings that might be possible in comparison with steam traction.** (Question 2, Enlarged Meeting of the Permanent Commission, The Hague-Scheveningen, 1956) :

Report: *(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and dependent overseas territories)*, by R.F. HARVEY . . 129

LIBRARY

OF THE

Permanent Commission of the International Railway Congress Association

READING ROOM : 19, rue du Beau-Site, Brussels.

Works in connection with railway matters, which are presented to the Permanent Commission are mentioned in the « Bulletin ». They are filed and placed in the library. If the Executive Committee deems it advisable they are made the subject of a special notice. Books and publications placed in the reading room may be consulted by any person in possession of an introduction delivered by a member of the Association.

Books, etc., may not be taken away except by special permission of the Executive Committee.

The Permanent Commission of the Association is not responsible for the opinions expressed in the articles published in the « Bulletin ».

All original articles and papers published in the « Bulletin » are copyright, except with the consent of the Authors and the Committee.

An edition in French is also published.

Vol. XXXIII. — No. 2. February 1956.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[656 .21 & 656 .25]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(THE HAGUE-SCHEVENINGEN, 1956.)

QUESTION 1.

Research on the economic usefulness and the technical opportunity to install a third track, serving for common use (banalisation), in addition to sections of double track lines with heavy traffic, instead of installing two double track lines on such sections.

Consequences of the installation of a third track for use in either direction on the conditions necessary to insure the safety of train movements.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, Netherlands, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and dependent overseas territories),

by V. J. M. De Blieck,

Chief Signalling Engineer, Netherlands Railways; Utrecht.

Preface.

The installation of three or more tracks on certain sections has been a practice of many years' standing. The reasons for the installation of these multiple tracks were not always prompted by the necessity to cope with a definite volume of traffic on these lines. Sometimes different Administrations operated parallel lines and when two tracks proved insufficient, they changed over to four tracks. In this decision, considerations of safety and possible mutual hindrance by traffic streams probably played a part.

However this may be, it may be assumed that traffic densities were generally not

of such a nature for these multiple tracks always to have been economically justified.

The modern railway undertaking, however, should now seriously think of rational and efficient operation in its competitive struggle with the other means of transport.

Consequently « operations research » and « automation » should not be allowed to remain mere conceptions for railways, but must also become realities, notably in the field of traffic regulation.

It is understandable that in this light, the trend towards a better utilization of tracks by applying modern techniques, calls for continual attention. Notably in the U. S. A. serious attention was therefore given to the removal of unremunerative portions of tracks in the last few decades.

In this connection the intention of the New York Central Railroad should be mentioned, to take up two tracks of a four track section over a distance of 300 miles, which, *inter alia*, has become possible by application of recent developments in the field of signalling technique. Such a project is of great economic importance. For the cost of renewal and maintenance of the track form a material part (usually 15 to 25 %) of the total working expenses. For the annual costs of 1 km of track, amounts, varying in the different countries from $ 1 000.— to $ 5 000.— are given.

Now, Question 1. relates to a particular application of this trend towards efficiency in the use of tracks, in particular for sections of more than two tracks.

Before, however, broaching this problem, it may be useful to recall the following recommendation of the American Railway Engineering Association, inserted in its Manual :

« Where the volume and distribution of traffic on multiple track line are such as to cause delays to trains sufficiently serious to warrant the consideration of means of affecting relief, the operation of opposing and following movement of trains by block signals is recommended for improving train operation and *as affording a means of increasing capacity at a small expenditure comparable with the cost of additional facilities sufficient to give relief.* Railroads operating in this manner must provide proper signals to control the approach and movements of trains ».

Exposition of the problem.

As for the problem of three versus four tracks (*) it may be well to look, in the first place, into its origin. Although it is sometimes generally remarked that this problem arises as soon as so many trains have to be conducted over a double-track section that they cannot be handled without causing undue delays, this answer proves on further consideration, if not wrong, to be very incomplete. For several cases are known in which, by application of automatic block system, a very large number of trains is conveyed over a double-track section, for instance 1 100 trains a day.

On the other hand, there appear to be cases in which on sections with 89 trains a day a third track is considered justified. From these actual data it may be concluded that the number of trains is not the primary cause of the problem. Therefore, it proves more correct to state that the problem of three or four tracks arises as soon as traffic becomes of such a nature that non-stop overtaking of trains is necessary to prevent serious delays. Naturally, traffic on the line under consideration should exceed a certain volume, as otherwise, also in the case of reverse running on double track, non-

(*) By a three or four track section in this report is meant a section with three or four tracks between two or more stations or between a station and a junction, the latter not belonging to this station, on which tracks trains will run.

stop overtaking could be applied. The recommendation of the A. R. E. A. quoted above bears on the latter case.

So the problem applies to various types of traffic and owes its origin to the working of traffic units (trains) at different travelling speeds. In this light, it is clear that attempts at working traffic units at equal travelling speeds as far as possible, deserve very special attention in order to raise the capacity of the tracks available.

In order to investigate this problem more closely, a questionnaire was drawn up for the purpose of obtaining relevant data on :

a) overall traffic picture when installing three tracks, together with an idea of the capacity of the tracks;

b) the various means for traffic regulation and the experience gained with them;

c) costs of factors related to the problem;

d) special safety measures, necessary in the case of « banalisation ».

As it was feared that the problem does not yet present itself with many Administrations in practice, a theoretical study was asked for in those cases where no data could be supplied from experience.

The questionnaire was sent to 34 Administrations. Answers were received from 26 Administrations, but only 6 of them gave a more or less complete answer.

Data were received about a total of 205 km of three track sections. For the treatment of the problem of three versus four tracks, a classification into the four following chapters has been chosen :

1. Overall traffic picture and capacity.
2. Traffic regulation.
3. Economic considerations.
4. Technical considerations for safety.

1. Overall traffic picture and capacity.

In the table of Fig. 1. a survey is given of the overall traffic picture for different three-track sections. From these data it appears that a third track for use in either direction is actually worked by a volume of 52 to 214 trains a day. So this volume hardly exceeds the capacity of two « banalised » tracks.

It is, however, the irregular spreading of traffic over 24 hours, combined with the fact that during the peak hours, the ratio between fast and slow trains is high, which may explain the installation of a third track in these cases. An indication of the irregularity in volume is provided by the ratio between average and maximum volume per hour. In the cases mentioned above the average of these ratios is 0.5.

With regard to the capacity of a track a distinction can be made between operational and potential capacity. By operational capacity is meant, as a rule, the number of trains which can be conveyed over a section per 24 hours without undue delays. For a single track section, for example, this capacity usually amounts to from 60 to 90 trains a day. It is clear that the capacity is not only a function of the track and signalling installations, but of the speeds of the trains and notably the differences between these speeds are also decisive for the capacity.

The potential capacity is the capacity calculated from the running times and lengths of block sections. In this calculation either a definite train-speed is assumed or a definite pattern for « mixed » traffic.

In order to reduce the capacity calculated to the practical capacity a delay factor (f) should be taken into account. So : operational capacity = $f \times$ potential capacity.

As a rule, the delay factor proves to be of the order of magnitude of from 60 to 80 %.

The following factors mainly restrict the capacity of a section :

a) the maximum time block sections are occupied, or the time single-track

ADMINISTRATION	SECTION OF LINE	Length in km	Number of trains per day					Average trains per hour	Max. trains per hour
			Express	Stopping	Freight	Light engines	Total		
C. & N.W. Ry	*a*) Elmhurst-West Chicago	26.5	24	53	12	-	89	3.7	8
C. & N.W. Ry	*b*) Clybourn-Barrington	45.4	55	44	6	-	105	4.4	15
C. & N.W. Ry	*c*) Clybourn-Wilmette	17.4	61	33	-	-	94	3.9	16
J.N.R.	Nakama-Chikuzan-Ueki *	6.4	-	35	138	-	173	7.2	16
N.S.	*a*) Tilburg-Tilburg Aansluiting	1.5	10	71	60	5	146	6.1	11
N.S.	*b*) Eindhoven-Woensel	4.0	23	80	92	12	207	8.6	11
N.S.	*c*) Bilthoven-Den Dolder	2.5	13	148	47	6	214	8.9	16
N.S.	*d*) Onnen-Groningen Losplaats	5.8	33	22	32	31	118	4.9	10
N.S.	*e*) Groningen Losplaats-Groningen	1.7	33	61	37	38	169	7.0	12
P.R.R.	*a*) Oakington-Bush River	14.0	68	7	27	-	102	4.3	6
P.R.R.	*b*) Bucyrus-Crestline	19.6	18	-	34	-	52	2.2	6
I.G.R. **	Howrah-Bahdreswar	28.2	38	176	8	-	222	9.3	28
S.J. **	Stockholm C.-Rosersberg	31.7	?	?	?	?	?	?	20

(*) Third track removed in 1954. Data apply to the traffic in 1944.
(**) The figures given for these Administrations are based on a theoretical study.

C.&N.W. Ry = Chicago and North Western Railway System.
J.N.R. = Japanese National Railways.
N.S. = N.V. Nederlandsche Spoorwegen.
P.R.R. = The Pennsylvania Railroad Company.
I.G.R. = Indian Government Railways.
S.J. = Swedish State Railways (Statens Järnvägar).

Fig. 1.

sections, if any, are occupied. This time of occupation is determined by the train-speeds and lengths of trains and block sections or of single-track sections. When installing an automatic block system, very short blocks may be chosen;

b) the traffic pattern, notably the number of overtakings and in the case of tracks which are worked in both directions, also the number of crossings. The number of overtakings gives a criterion for the inhomogeneity of the traffic-units;

c) the system applied for traffic regulation.

It may be stated that the capacity of a three-track section, one track of which is « banalised », will generally be not much greater than that of a double-track section, both tracks of which are « banalised » and between which connections by means of points have been fitted in appropriate places.

For the advantage of a third track is, as stated above, the possibility of non-stop overtaking. Now, in many cases, non-stop overtaking will be possible on « banalised » double-track, while in cases where it is not possible it will often be necessary to install four tracks.

For it is to be expected that a third track only gives a solution when the traffic satisfies the following requirements :

a) traffic in a definite direction should be sufficiently frequent during a certain interval. At the same time it should be considerably « mixed » i.e. the ratio between fast and slow trains should be sufficiently great;

b) traffic in the opposite direction should be sufficiently frequent in the interval considered, but should not make non-stop overtaking necessary. Should this traffic not be sufficiently frequent, two « banalised » tracks would suffice and should traffic in this direction also make non-stop overtaking necessary, four tracks are required.

The information received seems to conform to the above.

Situations which are often marked out for the installation of three tracks are those in which suburban traffic is conducted over fairly long distances over the same tracks as long-distance traffic.

A characteristic instance is given in appendix I.

It may further be observed that it appears from the data received that the average length of block section generally lies between 2 and 3 km. This is also an indication that in these cases an extremely high train frequency is not in question here.

From the answers received, it would appear that in a particular case the guiding factor in the installation of three tracks is the consideration that traffic can be worked more flexibly than over a double track section which is already being worked at almost full capacity. Although it must be recognized that this means is effective, it is very doubtful whether it is the most efficient solution. The reporter is of the opinion that in such a case it should first be examined to what extent modernisation of the system for traffic regulation gives improvement.

2. **Traffic regulation.**

At a given state of traffic there are two means available to improve capacity :

a) the installation of more tracks;

b) the application of more and better means of traffic regulation. This may, if necessary, include the introduction of additional connections between the tracks.

The installation of more tracks has been a method of many years' standing.

If overtaking must take place on a double-track section, it can be effected in this case by installing overtaking tracks in appropriate places. In the case of non-

stop overtaking the latter system leads, by its very nature, to three- or four-track sections, according to whether or not, it is desired to overtake in both directions. It is evident that this method is generally a very expensive one.

Starting, however, from the technique of traffic regulation, different and, as a rule, more economic solutions are sometimes reached. In the case of overtaking of trains on a double-track section, for instance, the question then immediately arises whether non-stop overtaking may be possible by partly or fully « banalising » the two tracks. This possibility, however, is, apart from the state of traffic, also decided by the possibility of surveying the situation from a central point and of taking immediate action to regulate that traffic.

In this connection, the various systems applied to train regulation, in which trains run on signal indication, may be briefly recalled. The systems of running according to « time table » and « train orders » may as well be disregarded, in view of the volume of traffic to be considered in the present problem.

The systems referred to above are :

a) traffic regulation between neighbouring stations by operators;

b) traffic regulation in the form of dispatching by a « train director » giving instructions to local « operators »;

c) centralised traffic control (C. T. C.). In this system, which is applied on a large scale especially in the U. S. A., the « train director » as a rule, acts on his own without the assistance of « operators ».

It is clear that, in proportion as the traffic picture is more complex and the time for regulating traffic shorter, C. T. C. is to be preferred to dispatching and the latter again to the system of regulation between the neighbouring stations. In the latter case co-ordination of the individual opinions about a common problem is not possible. In 1932, therefore, the Signal Section of the A. A. R. rightly recommended the introduction of C. T. C. as an economic means to put off capital expenditure for additional tracks.

If reverse running on a double-track section is not an effective solution, then the next step remains to examine how far « banalisation », together with the installation of one or more « loops », provides a solution.

Only when this proves insufficient, does this technique in some cases also lead to a solution with three and, generally to a solution with four tracks.

It is to be expected that, when installing three tracks, the greatest capacity can be reached by providing connections between tracks in appropriate places and by introducing C. T. C. for traffic regulation.

Again, it is of great importance that the connections between tracks are constructed in such a way (e.g. 1 : 15 or 1 : 20) as to enable running at high speeds to prevent delays, when crossing from one track to another, as much as possible. It implies at the same time that the signalling system should enable running over these points at the permissible speeds, as a system with insufficient speed indications can completely offset the value of high speed « turnouts » in respect of this problem.

Furthermore, one may ask how the connections between tracks must be situated in respect of each other and how the change-over to two tracks must be effected. For the connections either of the two schemes set out in Fig. 2. and Fig. 3. are used; both are of the same value, but evidently the solution according to Fig. 2. is most often applied. In connection with what has been said before, an equilateral solution is the best for the change-over from two to three tracks. See Fig. 4. and appendix II.

The general opinion is that the middle track must be « banalised » in order to be hampered as little as possible by con-

flicting streams of traffic. Only in particular cases may this rule be deviated from, for instance, when slow traffic is working on one and the same side of the three-track section and moreover, the frequency of this traffic is such as to be capable of being run completely over one track. In this case it is, however, more correct to speak of a double-track section by the side of which a single-track section is situated.

FIG. 2

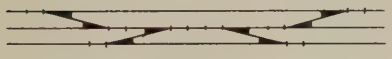


FIG. 3

FIG. 4

It may further be observed that also with a solution of three tracks, side-tracks or running loops will often be necessary for the handling of local goods trains.

When C. T. C. is introduced, the time taken in working points and signals, is lengthened by the time necessary to transmit controls and indications from or to the central post or office. The possibility of introducing C. T. C. for extensive lines with many points and signals and a frequent train service is sometimes called into question, because of the fear that in such a case C. T. C. equipment would not make a sufficiently rapid control possible. It may be stated that the possibility of C. T. C. in such cases stands or falls by the transmission times of orders and signals. The times required for it prove, as a rule, to be from 3 to 5 seconds.

The Swedish State Railways intend to apply a system in which these times will be about 0.4 sec. Recent technical developments in this field permit very short times for it, namely 1.5 sec. for a control for one or more routes (the control of a route includes a signal with the points behind it) and 0.01 sec. for an indication. Such short indication times even enable a continuous indication of the situation on the line to be obtained.

Although, according to the opinion of the Administrations who have experience in this matter, in practical cases the « train director » is not fully charged with the traffic control over a three-track section, the task of the « train director » could, where necessary, be relieved by applying technical devices such as automatic graph recorders (*), systems for automatic train identification (the Swedish State Railways intend to use this) and radio for communication between the « train director » and the train personnel.

One might imagine that the task itself of the « train director » might be open to partial automation by building on the automatic routing system recently introduced in suburban traffic, in which the train itself, when approaching certain points and signals, places them in the position required. Thus one might come to « automatic traffic control ».

Finally, a word about the consequences of failures in the equipment for traffic control. It may be assumed that, in the case of four-track sections, technical failures will generally have less serious consequences for traffic than in the case of three-track sections. According to information received, however, experience teaches that on three-track sections with C. T. C. the effect on the traffic due to failures is negligible.

(*) To get an idea of the extent to which automatic graph recorders are used, it is stated that 64 of such installations were in operation in U. S. A. in 1951.

3. Economic considerations.

With the economic considerations of this problem we should start from the assumption that the cost of stopping on a side-track may be less than the cost for maintenance and renewal of the tracks necessary to prevent this. In this connection it may be pointed out that the economic necessity for three or four tracks should primarily be determined by the economic benefit of the expected number of daily non-stop overtakings.

This being observed, it is clear that where the necessity for three or four tracks is primarily determined by schedule, the demands made of the schedule should economically be justified.

Various factors, however, such as providing service, competitive position in respect of the other means of transport etc., play a part and lie outside the scope of the problem considered, although, as a matter of fact, they will have to be taken into account. This consideration is particularly pronounced, where a fourth track might require very expensive structures.

With regard to goods trains the problem is somewhat simpler, at any rate, in the case of not too great losses in time. Notably, the costs of a goods train-hour as well as those of stopping and starting of a goods train are often known. For them, amounts are given of from $ 38.— to $ 225.— and from $ 0.90 to $ 3.75 respectively.

From these amounts as well as from the costs of additional track, the consideration mentioned in the beginning of this chapter could be verified. In this connection, however, it may further be observed that losses of time in overtaking rapidly rise with an increasing number of trains. For in this case, the number of overtakings increases more than proportionately, the losses of time in overtaking being greater than, for instance, in crossing.

In the exposition below, the schedule is bound to be considered as fixed. In consequence of this consideration it is difficult to express a concrete opinion on the economic value of three or four tracks. What we can do, is to examine both alternatives more closely, assuming the particular case that, whilst possibly applying the most up-to-date means of traffic control, traffic could be handled over three tracks.

For this purpose we can draw up a comparison of cost for a section of say 10 km, assuming that no special measures have to be arranged for laying the tracks (for instance the construction of structures, removal of buildings, etc.) and that the tracks concerned have not been electrified. Furthermore, we put the average length of block sections at 2.5 km and the average distance between crossovers at 5 km.

From the data obtained, according to table Fig. 5., it is to be calculated very roughly that for the case described above, the costs of the solution with three tracks are 77 to 97 % of those for the solution with four tracks. In the case of electrified lines, this proportion changes to the detriment of the solution with four tracks.

It would appear from the preceding exposition that the solution with three tracks is generally preferable from an economic point of view. It should, however, be observed that in existing cases, in connection with reconstruction of station track layouts, the difference may become slight whilst, in the case of a change over from two to four tracks, the increase in capacity is greater than when changing over from two to three tracks.

It should also be taken into consideration that on three-track sections, on which slow passenger trains run, two platforms are necessary for each station, four-track sections generally needing only one platform. On the other hand, the necessity for the construction of large structures may cause a fourth track to become extremely costly.

CAPITAL COSTS (in U.S. $)

ADMINISTRATION	1 km of track	Pair of points	Aut. block (average per km)		Electr. point equip-ment	Signal equip-ment (high)
			one direction	both directions		
C. & N.W. Ry.	30 000 to 60 000	6 000 (1 : 20)	3 100	4 900	5 600	9 400
J.N.R.	112 000 to 123 000	2 700 (1 : 16)	–	–	1 700	–
N.S.	38 000 53 000 (electr.)	3 200 (1 : 15) 5 100 (electr.)	4 350	8 050	2 900	2 900
P.R.R.	54 000 147 000 (electr.)	8 900 (1 : 20) 11 900 (electr.)	5 250	10 500	20 000	8 000
I.G.R.	40 000 to 50 000	1 900 (1 : 12)	–	–	–	–
S.J.	106 000 (electr.)	2 900 (1 : 15)	1 100(*)	1 350(*)	3 000(?)	3 000(?)
ANNUAL MAINTENANCE COSTS (in U.S.$)						
C. & N.W. Ry.	1 860	500	160	240	280	460
J.N.R.	3 900 to 4 100	100	–	–	–	–
N.S.	1 050	100	120	240	80	80
P.R.R.	4 400 5 000 (electr.)	300 600 (electr.)	300	490	1 200	400
I.G.R.	330	–	–	–	–	–
S.J.	–	–	120(*)	150(*)	270(?)	270(?)

(*) exclusive of cable cost.

C. & N.W. Ry = Chicago and North Western Railway System.
J.N.R. = Japanese National Railways.
N.S. = N.V. Nederlandsche Spoorwegen.
P.R.R. = The Pennsylvania Railroad Company.
I.G.R. = Indian Government Railways.
S.J. = Swedish State Railways (Statens Järnvägar).

Fig. 5.

4. Technical considerations for safety.

From a safety viewpoint distinction could be made between the solution with three and the one with four tracks, for in the case of three tracks one of the tracks is run in both directions.

One sometimes hears the conception upheld that running on tracks in both directions, would essentially be more dangerous than running on a line in only one direction. When, however, examining the history of accidents in the various Administrations, facts rather seem to point to the reverse. As a matter of fact, therefore, when using up-to-date equipment for automatic block system, including interlocking which prevents conflicting movements, there are no apparent reasons why the one should be less safe than the other.

For theoretical reasons, one might expect differences as regards the consequences of passing a signal at danger, notably so between the consequences of head-on and rear-end collisions.

As regards this expectation, however, in the opinion of the reporter it does not appear convincingly from the facts that head-on collisions are generally more disastrous in their consequences.

In U. S. A., therefore, as appears from the « Interstate Commerce Commission Rules », this « difference » in safety is not recognized, for, when running on a track in both directions no other additional measures are required than interlocking which prevents conflicting movements. So, neither special « derail protection », nor train control, nor cab signals are required as additional measures.

The requirement of using the latter equipment is only linked with a definite speed limit, independent of whether or not the working is in both directions. Some other countries, however, generally seem to apply measures to reduce as much as possible the consequences from passing signals at danger, by means of diverting points.

As regards this « derail protection » it may further be remarked that the problems for a three-track section, would be similar to those for junctions. In so far as in the latter cases « derail protection » was used, it has been abandoned almost everywhere, as preventing a collision by causing a derailment is not considered to be a good safety method. So this experience bears on the above-mentioned American practice. Installation of an overlap behind the signals is a better solution in this case.

This method is widely applied in Europe; its value, however, is considered doubtful by other Administrations.

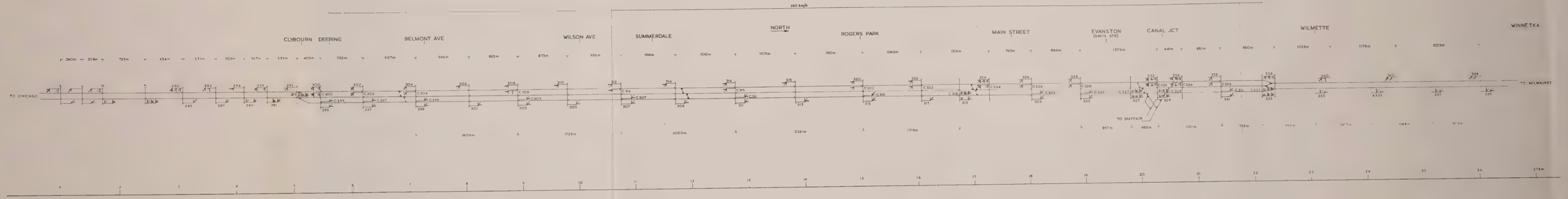
Finally, it is underlined once more, that when installing a third track with crossover points suitable for high speeds, both for the benefit of operation and for safety, a signalling system should be applied in which the various rates of speed can be clearly indicated and the relevant decreases in speed can be announced from a sufficient distance. It may be observed that, as appears from the replies received, several signalling systems offer insufficient possibilities in this respect.

Conclusions.

1. If, even after « banalisation », undue delays still arise as a result of overtaking of trains, a double track section must be extended by one or more tracks. So, this necessity for extension is, in principle, only dependent on the given inhomogeneity of the traffic and independent of the number of trains per 24 hours.

2. If, in the situation mentioned in 1, the slow or fast traffic, when taking into account a certain period in the day, has always one definite direction, this traffic can generally be handled over three tracks, one of which is « banalised ». If this is not the case, four tracks are required. The solution with three tracks is particularly indicated in those cases where long-

APPENDIX I

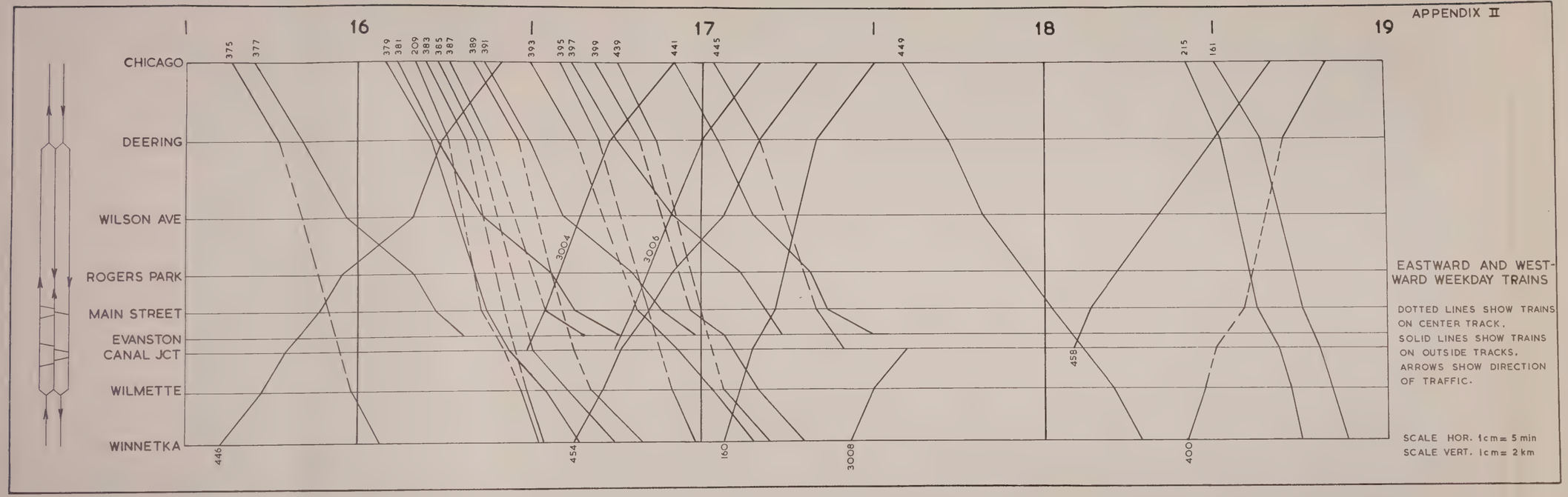


- SET OF POINTS
- CROSSOVER
- INSULATED RAIL JOINT
- AUTOMATIC SIGNAL (3-POSITION)
- SEMI-AUTOMATIC SIGNAL (STICK)
- SEMI-AUTOMATIC SIGNAL (NON-STICK)
- NON-AUTOMATIC SIGNAL (2-POSITION)
- NORMALLY LIGHTED MARKER (STICK)
- GANTRY (SIGNAL BRIDGE)

CHICAGO – WINNETKA

SCALE HOR. 1 : 40 000

APPENDIX II



EASTWARD AND WESTWARD WEEKDAY TRAINS

DOTTED LINES SHOW TRAINS ON CENTER TRACK. SOLID LINES SHOW TRAINS ON OUTSIDE TRACKS. ARROWS SHOW DIRECTION OF TRAFFIC.

SCALE HOR. 1 cm = 5 min
SCALE VERT. 1 cm = 2 km

distance suburban traffic is conducted over the same tracks as normal traffic.

3. If a solution with three tracks is applied, it is desirable, in order to obtain greater flexibility among other advantages, to install crossover points in appropriate places which, if possible, are constructed in such a way that trains running over these points need not slacken their speed. The middle track should be « banalised ».

4. If the permissible speed over the points, mentioned in 3. is less than the maximum speeds permitted on the sections in question, the decrease in speed should be indicated adequately by signals.

5. It may be expected, apart from the case mentioned in 2. that the operational capacity of three tracks will generally not be greater than that of two tracks which are both « banalised » and between which crossovers have been constructed in appropriate places.

6. When installing three tracks with connections between them, it is to be expected that the maximum capacity may be reached by a suitable location of the signals and by introducing centralised traffic control (C. T. C.).

7. If on a double track section a situation arises, or is to be foreseen, in which considerable delays arise, when looking for an economic solution both extension of the facilities and adjustment of the schedule should be taken into consideration.

The optimum, from an economic as well as from an operating and technical point of view, will generally be attainable if a mutual adjustment takes place.

8. If a solution with three tracks is possible from an operating and technical point of view, this solution is generally preferable from an economic point of view to that with four tracks.

9. The solution with three tracks need not be inferior to that with four tracks from the point of view of safety.

« Banalisation » does not require any additional safety measures other than interlocking to prevent conflicting movements. Some Administrations are in favour of « overlaps » as an additional safety measure.

[656 .23]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(THE HAGUE-SCHEVENINGEN, 1956.)

QUESTION 3.

Development of railway tariffs. Economic justification of these tariffs. Adjustment of tariffs to the new conditions of the general economic system and to the competition of the other forms of transport. Function of tariffs in coordination of inland transports.

REPORT

(Austria, Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Greece, Hungary, Italy, Lebanon, Luxemburg, Netherlands, Poland, Portugal and overseas territories, Rumania, Spain, Switzerland, Syria, Turkey and Yugoslavia),

by L. ANTOINE,

Directeur du Service Commercial à la Société Nationale des Chemins de fer belges.

The interest of the proposed question has been stressed by the fact that the multiplicity of tariff systems and classifications of freight is a constant source of difficulty when carrying out economic surveys.

The report, which follows, is based on the replies received from Railway Administrations or competent organisations in the following countries :

Belgium, Cameroons, Belgian Congo, Denmark, Spain, Ethiopia, Finland, France, Greece, Hungary, Indonesia, Italy, Madagascar, Holland, Portugal, Switzerland, Syria, Tunisia, Viet-Nam.

I. PRELIMINARY CONSIDERATIONS.

Whatever the railways covered by the present report, the most remarkable fact in the evolution of the tariffs is the similarity of the tariff phenomenon.

Originally, the tariff system was simple. It was perfectly adapted to the cost of operating an elementary railway system and its still primitive economy. The rapid development of the railways together with the rise of the great modern industries, led to discrimination in the tariffs. As essential instrument in economic progress, the task of the railways was to promote to the maximum the mobility of labour, to favour the regular transport of raw materials, and distribute the finished products as widely as possible. This brings us to the epoch when the Railway Administrations enjoyed a monopoly in fact, and adopted a rating policy the chief characteristics of which

still survive at the present time in most countries :

Passenger tariffs. — Differential rates according to the degree of comfort intended to tax the traveller according to class and wealth.

Maintaining workers' season tickets at a level which does not cover costs.

Freight tariffs. — Classification of freight into numerous classes according to its intrinsic value. Expensive goods carried at higher rates than the cost price to form the counterpart to the loss of revenue due to carrying goods of little value at low rates.

Rates decreasing with the distance in order to correct the geography of outlying districts. The lack of revenue due to this excessive decrease is compensated by the profit made on carrying goods over short and average distances.

Finally, in general, the budget is balanced by the revenue from « freight » making up for the deficit from « passenger » traffic.

* * *

A systematic study of the tariff systems now in force shows that there is a definite evolution in conceptions. We will report the essentially new characteristics whose incidence is such that the very structure of the traditional tariff policy is on the verge of being profoundly upset. The reasons for this evolution are the necessity for adaptation to an essential dynamic economy, the final loss of a monopoly and the rapid expansion of competitive facilities. This evolution is impeded by a superannuated judicial and institutional framework, the weight of tradition.

To various degrees, the Governments have understood the urgency to recast the legislation, the need for co-ordination in relation with the serious difficulties experienced by a method of transport which is one of the important heritages of the nation. In fact, it is always admitted that the railway is an efficient and cheap tool which plays an essential part in the economic life of the country.

II. REVIEW OF THE PRESENT TARIFF STRUCTURE.

A. Passenger tariffs.

Number of classes. — In general the tariffs in force on the main line railways provide for three classes of passengers. However, in certain countries where a large proportion of the population has still only a low living standard, there are four classes as there were originally on the railways.

In this order of ideas, we may mention the recent giving up of the 4th class in Indonesia.

On the other hand, in Europe, the railways show a tendency to reduce the number of classes from 3 to 2 by doing away with first class. This reform has already been made in the internal services in Denmark and Belgium, and is in hand in France, Portugal and in other countries.

It is likely to be very widely extended during 1956.

The light and urban railways show a tendency to have only one class. This is the case with the Paris Transport Board, who are hoping to introduce a single rate over the whole of their system, and the Belgian National Light Railways who have already done so.

Certain Administrations charge supplements for the use of certain express trains (France, Belgium, Spain). The trains in question usually have only two classes.

Reduced price tariffs. — Tariffs of this sort can be divided into three categories :

a) reduced tariffs depending on the category to which the passenger belongs;

b) reduced tariffs depending on the number of journeys;

c) reduced tariffs based on the number of passengers travelling as a group;

a) It can be agreed that most railways carry infants free of charge and children at half price up to a certain age. If the character of these facilities is essentially

of a social order, it is not absolutely incompatible with the commercial interests of the railway.

But, this does not apply to the reductions of as much as 25 to 75 % granted to a large number of categories of passengers, essentially to the following :

— ex-soldiers and war-wounded;

— ex political prisoners and other war victims;

— members of large families;

— members of public administrations;

— members of the armed forces and police.

b) Most Administrations offer an extensive scale of facilities to passengers using their services regularly and frequently :

— generally, return tickets are issued at a lower rate than the double of the single tickets. Apart from reasons based on competition, the justification for such a reduction is not admitted by every railway;

— of late years, the Administrations have been selling cards giving a right to cheap tickets for a given period;

— most railways also offer a very wide range of season tickets, the chief of which are :

i) season over the whole system;

ii) ordinary season;

iii) workers seasons for employees and workmen;

iv) scholars season.

If we except the seasons over the whole railway system and ordinary seasons, where the reductions granted are justified in theory to a certain extent and according to the case for commercial reasons, the information collected from the various countries shows very clearly that workers and scholars seasons produce insufficient revenue to cover the actual cost of the services to which they apply. Social and economic considerations deprive the railways of « normal » receipts. By « normal » receipts we mean those where the reduction on the ordinary fare corresponds to a reduction in costs due to the simplification of the work at the booking offices and the improved user of the rolling stock.

c) In order to encourage tourist traffic in groups and fight road competition, the railways grant very varying reductions to organised groups according to the number in the group and the journey in question. When the Administrations have to run special trains or railcars, they usually make certain that the direct costs involved will be covered.

B. **Freight tariffs.**

The continuous evolution of the tariff philosophy is very clearly shown in the structure of the freight tariffs. The Administrations whilst not making a sudden break with the classical conception of « ad valorem » rates are actively looking for formulae based upon certain ideas regarding costs.

Incomplete loads. — Certain countries, such as Indonesia have retained the « ad valorem » classification for deciding the cost of parcels traffic. But most countries use a common scale for all freight. The rates take the following factors into account :

Speed of the journey. — Express goods traffic is usually worked by passenger trains. Fast goods by the parcels trains. Slow goods has been given up in most countries since the last war.

Distance. — The scales are usually on a decreasing basis according to the distance which is calculated from station to station. However, in certain countries, the distance on which fast goods traffic is based is that between the stations which run the door to door collection services (Belgium).

Weight of the consignment. — Generally, there is only one series of rates for fast goods whereas in the case of express goods differential scales are used based on considerable differences in weight.

Kind of goods. — Ordinary goods are rated according to their real weight, whilst light bulky goods are rated according to weight plus a certain percentage (generally 50 or 100 % according to the case).

As a special case, we might mention that in order to obtain a truer approximation to the real cost, in France and Belgium the cost of the door to door services has been included in the « Express » goods rates and surcharges are made in the case of collections and deliveries in rural areas.

Full loads. — The classical formula for the « ad valorem » rates is a whole range of classes more or less numerous under which the goods are booked according to their intrinsic value. Each of the classes has several series of decreasing rates according to the weight (for example : 5 t — 10 t — 15 t).

This formula is still used in many countries where it is the backbone of the general rates. However, if we compare the classifications of goods in the various countries, we find many discrepancies. These are due to alterations that took place on account of the economic conditions in each country, to the competition of other methods of transport, and to many factors quite outside the pure idea of value.

We would also like to stress the fairly general use made of the constant reduction in the number of generally applicable rates and consequently in the « ad valorem » tariffs. Each day they are becoming more and more confined to transport of an occasional and un-organised character. Special rates are becoming more and more important. These are dictated by economic measures, by the need to offer organised traffic competitive rates, and by the interest there is in improving the technical conditions of transport in order to obtain a cost justifying the reduced rates (number and frequence of the rates, making up full train loads, use of special stock, etc.). This is the situation to be found in particular in the following countries and railways :

Belgium. — Apart from the rates for solid fuels, the S. N. C. B. tariffs still cover 6 classes « ad valorem » which now only affect ± 20 % of the total traffic. The opening coefficient of the spread of classes at 100 km (62 miles) is $\frac{270}{114}$ = 2.38.

The S. N. C. B. is however the only Administration to apply the principle of the total consignment generally. For example a consignment of 20 t divided up equally between two wagons will be rated according to the 20 t scale on its total weight, and not on the 10 t scale for each of the wagons.

Belgian Congo. — The B. C. K. tariffs include 13 « ad valorem » classes.

The Djibouti - Addis - Abeba Railways have an « ad valorem » system covering 5 classes with the special feature that each of these only has tow series of rates : rates applicable to wagons loaded with under 5 t and rates applicable to wagons loaded with over 5 t. If a wagon is loaded to capacity, there is a rebate of 5 to 8 %.

Denmark. — The 7 « ad valorem » classes now in existence are very restricted in applicatiion since the Danish Railways are able to make special contracts, the terms of which do not have to be published.

Spain. — Agricultural products as well as many other goods benefiting by special rates are excluded from the three « ad valorem » classes still in existence.

Finland. — The classification includes 12 classes, the last two of which are special reduced rates ordained by the Government for certain goods. The opening values of the spread of classes 1 to 10 is 2.47.

Indonesia. — The Java Railway which is the most important in the new Republic has a general « single wagons » tariff covering 7 classes forming a spread of 100 km (62 miles) with an opening value of 2.

Madagascar. — Bulk transport and goods of general interest are excluded from the « ad valorem » rating which only covers three classes.

Netherlands. — The « ad valorem » tariff based on 4 classes only concerns unorganised traffic, as the N. S. are able to make contracts the terms of which do not have to be published.

Switzerland. — The C. F. F. have a tariff covering 4 standard classes and 7 special classes. They are likewise able to make contracts the terms of which do not have to be published in the case of internal traffic and traffic in transit.

In view of the above, it appears to us of great interest to be able to report in some detail the experience of the French Railways who have boldy tried to free themselves from the « ad valorem » tradition by adopting a general tariff the essential principles of which are :

— the classification of goods into 4 series according to their bulk :

1st series : products weighing less than 6 t per wagon of the usual type;

2nd series : products weighing less than 7 to 9 t per wagon of the usual type;

3rd series : products weighing less than 10 to 14 t per wagon of the usual type;

4th series : products weighing 15 t and over per wagon of the usual type.

For each series of products there is a scale of rates the upper limit of which is the average level of the rates offered by its competitors and the lower limit the marginal cost of railway transport. The « ad valorem » idea still comes into play between the limits defined above.

Mention must also be made here of the fact that even in those countries with a planned economy, for example Hungary, the tariff regulations have not been able to divest themselves entirely of the old « ad valorem » conceptions. In place of the old conception of the value, the Hungarian Railways have now substituted a classification based upon the economic and social value of the goods.

III. INCIDENCE OF THE IDEA OF COST IN DRAWING UP THE TARIFFS.

Though most of the Administrations consulted recognise the traditional tariff systems as having a certain foundation in fact, they are however tressing more and more the fact that the conception « the actual cost » should occupy an ever increasing place in present day rating philosophy.

The aim, all these railways have in view, is the balancing of the « total » receipts and expenditures. This objective could be attained in the case of a monopoly by general or total increases in the rates when there was an increase in the costs. Nowadays, thwarted by restrictions which are alien to ordinary industrial management and actively competed against by other forms of transport, the railways have been obliged to endeavour to derive the utmost profit from their transport capacity in order to get a maximum amount of total receipts with a minimum additional expenditure. This tendency is stressed in particular by the Swiss Federal Railways. The tariff policy will therefore be to make the fundamental and permanent traffic as far as possible pay enough to cover the total costs and to obtain new traffic which will at least pay for the additional expenditure actually involved. If in the case of such new traffics, the rates can be fixed at a higher level than the part costs, the fixed costs for the whole of the traffic will benefit thereby. This is also very similar to the theory of the French Railways which is centred on « marginalism ».

We do not see any point in going into the subtle distinctions between the idea of the variable costs and the marginal costs, but we would like to stress that, as far as possible, the Administrations should take greater care in selecting the new traffic to be accepted or the traffic to be consolidated taking into account essentially the new charges or the charges that will be avoided compared with the receipts to be gained or lost. The ultimate limit of the concessions to be granted within the framework of specific tariffs is the covering of the whole of the direct costs.

These considerations are confirmed in an analysis of the tariffs of the various railways as regards the « passenger » rates and the « freight » rates, although the latter are the more important in this connection.

Passengers. — In France, the Railways think the ideal would be for the whole of the costs to be covered by the « full » rates scale. The relativity of the fares in the different classes is determined by the cost of these classes, that of the cost of various types of season tickets by the frequence and regularity of the journeys made and the savings this makes in the work at the booking office. Cheap fares are intended above all to attract additional passengers from whom the railway expects to get at least enough to cover the direct cost of transporting them.

The policy of the Belgian Railways is very much the same, since the demands for compensation for carrying passengers at cheap rates for social or economic reasons are always put forward on the plea of the need to cover the total costs, whereas the transport of tourist parties is carried out under conditions intended to cover at the least the direct costs.

However, in Belgium, the relativity of the cost fares for the different classes is not exclusively based on the relativity of the costs, any more than it is in many other countries, such as Holland, Portugal, Denmark, Switzerland and Spain.

Freight. — The tariff policy to the extent that abstraction is made of factors outside the cost (for example, protective economic tariffs) can be easily summed up in most countries under three headings :

— the average level of the rates must cover the complete average cost, the objective being the balancing of the budget;

— the average marginal cost is the admissible limit in the case of generally applicable rates;

— the particular marginal cost is the lowest admissible limit for rates of limited application.

The importance attached at the present time to the idea of the cost is also shown by the fact that the railways do not hesitate to make up by regulations in favour of their clients part of the savings which they consider they have obtained by improving the technical conditions of transport or the releiving arrangements made to their advantage :

— consignments in privately owned wagons;

— consignments in large rakes of wagons (France, Belgium);

— consignments in complete trainloads (France, Belgium);

— making up trains on private sidings (France, Belgium).

When specific rates are granted for certain traffics which can be easily individualised, the Administrations in addition to purely commercial clauses (fidelity, guaranteed tonnage...) do not hesitate to make special arrangements to cut down the cost of production (importance and frequence of consignments, minimum tonnage per wagon, determination of the type of stock to be used...).

Several Railways, such as Portugal and Denmark, where studies of the costs have not yet been made to a sufficient extent, have stressed in their replies to our questionnaire that they are fully aware of

the interest of persevering in their endeavours to obtain a more thorough knowledge of the cost of their transport.

A knowledge of the factors involved in the costs, the way in which and the extent to which they vary as a function of the characteristics of the consignment have led the railways to make a better use of all the advantages of railway technique in the difficult fight they are waging against the competition of water and road transport.

Rates decreasing according to the distance. — Under this heading we have to deal with one of the most disputed characteristics of the classical theories in the idea of the « prime cost ».

Finland, who justifies reducing the rates in accordance with the distance as a function of the costs points out that traffic over long distances makes a relative reduction in the time taken to load and unload in the total time the stock is being used. However, they consider that the reductions now allowed are definitely excessive compared with this slight saving.

No one will dispute the fact that the time has passed when the railway, which no longer enjoys a monopoly, has to correct the geography of the country in favour of outlying regions. Except in countries where over long distances the railways compete against coasting vessels (for example Madagascar), they no longer have any interest in working at below costs over long distances.

Generally, the rates only decrease with the distance in the case of the freight traffic, whereas passenger fares are usually proportional.

As far as the curves of the costs are concerned, several railways have already corrected excessive reductions according to the distance. These can be corrected within the limits left by the idea of the value of the transport. In applying marginal theories, decreasing rates should be accepted in so far as they make it possible to cover the direct costs; they can be corrected to the extent that the rates demanded will not discourage the traffic owing to excessive cost of transport compared with the intrinsic value of the goods transported.

Taking these considerations into account, the French Railways have divided up the goods into three groups to which they apply specific decreasing rates :

— the most marked decrease is reserved for the group which includes heavy goods of little actual value;

— the smallest decrease is reserved for those finished products of the greatest value.

In Holland, at the present time the possibility of doing away with any mileage reductions after 250 km (156 miles) is under consideration. In the same way, in Sweden and in Finland, where the mileage reductions are very great, it is being investigated whether they are not excessive compared with the cost per ton-kilometre.

In Belgium, recent modifications in the internal services have been intended to reduce the rates for distances of less than 100 km (62 miles), the reforms considered tend to correct excessive mileage reductions, as balancing the profit from the average distances and the lack of profits over long distances is no longer possible owing to road competition. In addition, it can be considered that in the case of a country of small size all the classes can be given an identical coefficient of decrease without the bottom of the scale being too high and discourage transport of little economic value.

Other Railways (Spain, Belgian Congo, Djibouti - Addis - Abeba and Cameroons) have considered it better to retain proportional rates for the general classes and include the curves of decreasing rates within the framework of their special rates.

With the exception of the recently published tariffs of the Coal and Steel

European Community, no common law for decreasing rates in the case of freight tariffs can be found.

IV. ECONOMIC INFLUENCES ON THE TARIFF POLICY.

If we go back to the era when the railways enjoyed a quasi-monopoly, we see that the classical rating policy which decreased according to the value and distance was most suitable to the national economy. This favoured to the maximum extent the movement of goods and brought the industrial centres nearer to out-lying centres of consumption.

In our times, apart from peremptory obligations imposed by the public authorities, the essential of the rating policy of the railway companies shows the tendencies common to all industrial undertakings : it consists in trying to conciliate its financial interests with those of its clients thanks to a rational production programme.

On this point, indeed, not all the Administrations are as categorical as the Netherlands Railways who define their policy as follows : « The railway must be run like a private undertaking and consequently its financial equilibrium must be assured. In this conception, there is no room for a tariff policy aimed at the welfare of the national economy. »

It is not only in countries with a new economy that we find tariffs favouring the imports necessary for the national production and the export of native produce. It is quite common to find in the tariffs of European countries rates which are definite subsidies to one particular industry or to a given economic sector.

Under this heading may be included workers season tickets when the reduction allowed is excessive as being a definite subsidy to industry (Belgium, France), certain special rates for agricultural produce, fertilisers, fuels (Spain, Portugal, Italy) as an integral part of the costs and wages policy of the Government.

In many countries, the State uses the railways as far as possible to assure the success of its economic and social objectives. All the measures imposed by the State are not always contrary to the financial interests of the railway, but in fairness it must be recognised that any cost which is not completely covered falsifies to a certain degree the commercial accounts intended to balance the budget in the presence of competitors who sometimes enjoy almost complete liberty.

V. TARIFFS OF A SOCIAL CHARACTER OF ECONOMIC SUPPORT IMPOSED BY THE PUBLIC AUTHORITIES.

If we except a few countries (Holland and Denmark), we find that as stated above the Governments make use to various degrees of the railways as an instrument in their social or economic policy. In general, in highly industrialised countries (France, Belgium), the essential objective of the Public Authorities is the mobility of labour and this is achieved by fixing workers seasons at excessively low rates. In France, the lack of profit is in theory made up, in Belgium it is partly compensated. In agricultural countries or those in process of being industrialised, it is above all in the field of freight traffic that the State acts : reduced rates for agricultural produce and foodstuffs, for raw materials required for the national industry, support tariffs in favour of a given economic sector.

We find that in certain countries there are support tariffs which apply to a specified product, characteristic of the economy :

— milk and timber in Switzerland;

— timber and peat in Finland.

As a subsidiary to this, we may mention passenger tariffs of a social character

which are ordered by the Government, giving reductions of from 25 to 75 % to certain categories of travellers : members of large families, invalids, ex-servicemen, etc.

Many Governments have made agreements with the railway by which they pay partial or full compensation for the loss of revenue due to measures imposed by them.

In certain countries, the loss of revenue is not made good, but the State is responsible for any operating deficit shown by the railways. However, when the pecuniary effects of the support tariff is negligible, it may happen that the railway gives up any claim to compensation (Madagascar).

The effects of such tariffs is naturally nil as far as the rating arrangements go when the lack of revenue is made up by the Public Authorities. If there is no compensation or only partial compensation, the general tariffs have to be stepped up to a level which will make the traffic more vulnerable to competition (Switzerland, Belgium).

VI. LEGAL OBLIGATIONS RESTRICTING FREEDOM IN FIXING THE TARIFFS.

The usual reproach, a well founded one, made to the railways rating policy is its lack of flexibility and force. The contrast there is with the way the road hauliers act, who are able to fix in each case a price, which takes into account the characteristics of the transport and the « resistance capacity » of the parties concerned, and the slowness of railway rating measures, has become too violent for there not to be an unfavourable prejudice when the consignor is making his initial choice.

However, there is no doubt that the Railway Administrations could be just as flexible as their competitors if they were only freed from a series of legal obligations dating from the time they enjoyed a practical monopoly.

This at least clearly appears from a study of the comparative position of the different railways.

The legal obligations which the majority of railways have to comply with are the following :

1. Confirmation of the tariffs by the public authorities represented :

in France and Denmark, by the Ministry of Public Works;

in Belgium and Holland, by the Ministry of Transport;

in Switzerland, by the « Bundesrat »;

in Belgian Congo, by the Governor General;

in the French Colonies, by the High Commissioners.

Thus after having been studied by the commercial department of the railways and approved by their Administrative Council, the tariffs are submitted for governmental approval, without, in most countries, the latter having to announce their decision within a given period.

2. Publication of the rates.

After governmental approval, the tariffs have to be published, as they cannot be legally effective until the legal period after publication has elapsed. This is generally done by publication in the appointed legal instrument, after which the public has the right to see and buy copies of the tariffs in the stations.

However, in Holland and Switzerland, the right to make special agreements, the terms of which do not have to be published, has been given to the railways to allow them to compete against other methods of transport and other systems in the case of traffic in transit.

Frequently obligations 1 and 2 cover all tariff measures whether of general application or limited application, whether they concern the whole country or only one single consignor. They also enable the State to exercice control over the railway tariff policy for its own ends.

3. Equality of treatment of all users fulfilling the conditions laid down in the tariffs.

This is a principle which already held sway at the birth of the railways during the last century.

* * *

In a previous chapter we insisted upon the consequences when the tariff policy has to be submitted for State approval, but we also think it would serve a useful purpose to show all the effects of publishing the rates and of equality of treatment for all users.

It might be agreed that the general tariff should be published since it affects various scattered and non-organised traffic which in theory might suffer possibly unfair treatment from the railway. But the same opinion cannot be held in the case of rates of limited scope affecting a given traffic the structure of which is such that the consignor has several methods of transport competing for his business.

Publishing the rates not only makes it necessary to grant equality of treatment, but annoys those consignors who cannot fulfil all the requirements necessary to enjoy the special rates so that they often threaten and in fact may leave the railway for its other competitors.

This means that the railways are very much handicapped when discussing prices. They often have to give the traffic up rather than suffer the loss of revenue entailed in extending the rebates to a foreseeable or unforeseeable extent.

As a corollary, there is also the nuisance of the delay in introducing the new rates after they have been published which makes it possible for competitors to lower their rates still more and takes away the whole object of the new rates before they have even come into force.

To sum up, tariff obligations make it impossible to hold discussions to determine the « fair rate » to which liberal thinkers refer. Under present competitive conditions, the railways constantly have to reveal their objectives and thereby expose themselves to real extortion.

* * *

The iniquity of such a situation has already become apparent to many Governments who have reduced the tariff obligation to a greater or lesser extent, whilst safeguarding the interests of the public. We give below the most interesting aspects of some of these reforms :

Switzerland. — The law is very strict concerning tariff obligations, but it does tolerate the making of contracts on a penalty basis. The railways can make an agreement with an undertaking to assure all its transports for a fixed rate per unit of weight provided this is determined according to the average rates paid during a given period.

France. — The agreed rates may provision for a maximum and a minimum scale which form the limits between which the S. N. C. F. is free to fix its rates as it pleases. The S. N. C. F. is also authorised to grant certain special rates which it merely has to communicate to the Minister of Public Works.

Denmark. — The rates are decided by the Minister of Public Works on the basis of the maximum rates laid down by law, upon consulting a railway council and with the agreement of the Budget Committee of the National Assembly. However, the Minister may authorise without other formality the General Manager of the railways to lower within the framework of the « unpublished rates » the passenger rates by 50 % and the freight rates by 25 %.

Finland. — The General Management of the Finnish Railways has the right to make special agreements of a similar kind with all consignors fulfilling the same conditions.

Holland. — In this country, the utmost has been done to give the N. S. the necessary commercial flexibility. Only the general rates are published. Reductions imposed by the Government are made up on the basis of these rates. But the essential point is the freedom to make unpublished contracts with consignors, with no other restriction than the need to balance receipts and total costs.

VII. LEGAL AND FINANCIAL RELATIONS WITH THE STATE.

A. Legal relations.

As things stand at present, in most countries, the State has given up the direct management of the railways for various reasons: the complexity of railway technique, realisation of an asset in order to improve the financial position of the State.

The solution generally adopted is the creation of a national or combined company, with financial autonomy, a legal entity subject within the limits of its statutes to the commercial law and obeying the requirements laid down in its specifications or basic law. The State generally holds half or the majority of the shares in the said companies (France, Belgium, Holland).

However, in some countries the State still runs the railways directly but with a strong bias towards decentralisation:

— in Denmark, the railway forms a department of the Ministry of Public Works, run by a general Manager « Departmental Head »;

— in Finland, the position is the same. Only the basic regulations governing the Administration, Operating and Tariffs are confirmed by decrees signed by the President of the Republic, who also names together with the Government the holders of the chief posts;

— in Switzerland, the situation is complicated by the fact that besides the Swiss Federal Railways there are numerous private companies.

The State considers these as companies with the obligations of a public service so that they have to assure all the necessary co-ordination measures. The C. F. F., as a State Administration, is subject to the political and administrative instruments of the State. The commercial policy of the railways in general is determined by a Conference at which the questions are decided in collaboration with the « consignors » and users. Any differences of opinion are settled by the Minister of Transport;

— in Spain, although owned by the State, the RENFE has its own legal entity.

In the new countries (Belgian and French colonies) the railways are private companies holding a contract from the Government.

B. Financial relations.

The financial relations between the State and the railways are regulated by both legal and factual conditions.

In the great majority of cases, the railway budget is separate from the State budget even if the State is directly responsible for the management of the railway and includes its financial results in its own budget at the end of the taxation year.

In view of the complexity of its working and the obligation to run it as a commercial and industrial undertaking, industrial accountancy has superseded the administrative accountancy which still deals with public finances.

An analysis of the financial links between the State and the railway shows the different situations.

In Holland for example, where the « Nederlandsche Spoorwegen » enjoys great freedom as regards its tariffs and is run with the minimum of interference, the State has no relations with the rail-

ways other than that of a chief shareholder towards an ordinary company. There is no deficit to make good and no subsidies to be provided for in the budget.

The situation is also simplified when the State itself operates the railway. At the end of the taxation year, the profit or loss is absorbed by the State and questions of subsidies and compensation do not arise.

In France, Belgium and Switzerland, where the railway companies are legal entities or where the charges imposed on them by the State are many and various, a series of agreements and treaties provides for the partial or total repayment of certain charges as well as the modulus upon which these are calculated, the State acting as a guarantor when repayable loans are raised, and providing various subsidies.

In the case of these three conutries, it is interesting to show certain striking particularities :

France. — The balancing of the budget is the concern of the State which guarantees the S. N. C.F.

The latter, as a public utility, at the express demand of the Public Authorities, has granted certain categories of travellers and freight special reductions on the normal rates. Compensation for these burdens is provided for integrally on the basis of an Agreement.

This Agreement also lays down that the State will pay its share in the cost of maintaining and renewing the permanent way, providing keepers at level crossings, the S. N. C. F. on their part having to pay a rent to the State.

The State also pays its share of the charges due to pensions paid to employees who retired before the 1st July 1949 and were not replaced.

The State also agrees to advances from the Treasury repayable before the end of the financial year.

Belgium. — Though the State is not legally obliged to make good the operating deficit of the S. N. C. B., it does guarantee certain compensation to make up for some of the burdens imposed on the railway as a public utility.

Reduced fares granted to war disabled, ex-servicemen and large families are compensated at the rate of half the difference between the standard amount for a single ticket and the reduced fare granted.

Reductions granted in the case of military transport are also compensated by 50 %.

On the other hand, the transport of goods required by the Army is carried out on the basis of a contractual rate calculated on the commercial rates and does not give any right to compensation.

In the case of season tickets for workmen which the State requires to be very cheap, the compensation amounts in principle to one half of the net loss calculated upon the actual cost.

At the present time, the State does very little to help towards the heavy burden of pensions granted to employees who completed their service when the railway was run by the State. This burden is also abnormally heavy on account of the excessive number of employees under the State regime (up to 1927) and because stability of employment could not be brought down to a normal level until recently.

Switzerland. — The operating deficit of the C. F. F. is covered by the State when it cannot be met from reserve funds. On the other hand, the law provides for assistance to the private companies to enable them to cover their deficits and improve their permanent way. This aid is granted partly by the State and partly by the Cantons.

The public authorities also grant a certain amount of compensation for keeping certain lines open during the winter.

* * *

In certain countries, the obligations of the State towards the railway are not based on legal bases but are the result of necessity.

In Portugal, the State in certain cases grants subsidies to the railway without there being any legal obligation for this.

In Spain, the Government authorises the necessary credit to balance the budget of the RENFE. However, the situation has now become such that direct assistance is seen to be necessary not only to assure the short term budget equilibrium but also to realise a whole programme of reconstruction and improvements to the railway system.

* * *

The principle of the integral compensation of burdens is officially admitted in the French colonies of Madagascar and the Cameroons. When the proposed tariff measures are not officially approved, the Territory has to make good the loss of revenue resulting therefrom. On the other hand, as far as improving the permanent way of the Cameroons Railways is concerned, the Territory pays the financial charges and the mother country 50 % of the investment.

* * *

The essential points in this long report are that in the only country where the railways are really run as a private company, the State has no other relation with them than that of a shareholder collecting dividends and in the other countries, the evaluation and compensation paid for the burdens and financial assistance of all kinds lead to a confused situation to such a point that it is extremely difficult to estimate the commercial management of the railways and the value of Government aid.

VIII. RELATIONS BETWEEN THE STATE AND THE OTHER METHODS OF TRANSPORT AND DISCRIMINATION BETWEEN THE LATTER AND THE RAILWAYS.

Within the framework of the present report, we do not think it would serve any particularly useful purpose to deal with the special case of air transport. The greater part of the air companies are companies of a national character in which the State is the chief shareholder. The rates and timetables are published. The cost of the installations are not always covered and for reasons of national prestige, the State makes up any operating deficit.

From the point of view of the co-ordination of internal transport, it is true that cases of traffic being transferred from the railway to air services may occur, but this aspect of the question is much less crucial at the present time than the problems set by the coexistence of rail, road and water transport. We will deal in turn with the scope and activity of the direct competitors of the railway, and then the discrimination, which in the present state of affairs, is usually against the railway.

A. Scope of road and water services.

Regular passenger road services.

In France, there is a decree making provision for a road tariff on a national basis, a national scale of application and for each line a basic tariff and applied tariff. In theory, the rates must be fixed by agreement with the S. N. C. F., but in practice they are generally fixed at a lower level than 3rd class railway fares. The rates and timetables are published. The lines are operated by authorisation from the Ministry of Public Works and are subjected to official regulations.

In Holland, the position is more or less similar to that existing in France as regards the publication of the timetables and tariffs, authorisation and specifications. The only difference is that the published tariffs are the maximum rates.

In Portugal, Switzerland and Spain, the obligations imposed are similar to those imposed on the railway as regards timetables, rates and obligation to operate.

In Denmark, the issuing of licences has

been assigned to the local centres which do not give any priority to the railway.

In Belgium, on the other hand, the railway and light railways have a right to priority. These companies make use of this right by working through private companies.

The concession-holders of the S. N. C. B. are paid on the basis of a formula of the cost.

The rates and timetables are published.

* * *

Occasional transport of passengers and freight by road.

In general, it may be considered that apart from an official authorisation intended to maintain a certain quota, the companies are completely free as regards their commercial policy and do not suffer from any of the burdens of a public utility. However, in certain countries, there is a certain amount of legislation regarding the rates (France, Holland, Spain) but this has not much practical import.

The rates in practice are below the « legal » rates, and are calculated upon the rate from station to station offered by the railway or determined according to the mutual strength of firms in competition against each other.

In any case, all controls are of little effect in view of the weakness of the means at the disposal of the governments and the great dispersion of the different companies.

* * *

It can therefore be considered that in general road transport enjoys complete liberty in actual fact, except in the case of regular passenger services. In this case, they are a public utility just like the railway as far as the publication of the rates and timetables and obligation to operate and carry are concerned.

In the case of transport on demand, however, there is complete anarchy, and the reduced rates offered as a result lead the firms to work below their costs. However, those which fail are soon replaced by new firms adventuring in their turn.

Nevertheless, there is a very definite tendency towards a gradual extension of organised undertakings, a tendency which is however slowed down by privately owned transport.

The development of their own transport by many concerns should be specially looked into.

* * *

Transport by water.

With a few exceptions (regular services on the Swiss lakes, which are subject to the same obligations as the C. F. F.) water transport is entirely a matter of freight services and has no public utility obligations.

In France and Belgium, inland navigation rates are fixed by an organisation of an official character which is decentralised.

In Holland, the internal tariff system lays down maximum and minimum rates between which the rates are freely fixed.

In general, the fixed rates are much lower than the railway rates. The object is to protect the transporter.

In fact, the structure of these services is such that the barge owners are isolated and unorganised and their clients are able to get them to compete against each other beyond reasonable limits. However, when space is short, consignors will often agree to supplementary charges which remain more or less a secret, or else the barge owners give priority to international transport which is more profitable.

B. Discrimination between the different methods of transport.

The above report has made it clear many times over that the various methods of transport are not treated on an equal

footing. The differences of treatment by the State are very various in character. Their analysis is the more interesting as it is only by trying to estimate them as accurately as possible that an objective comparison of the true value of the services of the different methods of transport is possible. In effect, in the case of a liberal economy where the burdens are shared out between the different methods of transport, the consignor's choice will be based on the value and real cost of the services. This cost will be approximately a function of the economic cost, i.e. the lowest cost for the community. Traffic will be shared out solely on the basis of the suitability and speciality of the different methods of transport. These considerations are particularly stressed by the Belgian, Dutch and Swiss Railways.

We will merely mention the most important discriminations, which will moreover enable us to allude later on to a few basic conceptions to be taken into consideration as regards the coordination of the various transport techniques.

The cost of the permanent way.

Railways. — In most countries, the railways pay for their own permanent way. They finance its maintenance, extension and renewal. The only State aid we have come across usually is the guarantee given when redeemable loans are raised. In France, the State pays ± 60 % of the cost of maintaining and renewing and 50 % of the cost of keepers at level crossings, though the total of these two subsidies must not exceed 12 % of the operating costs. On the other hand, the S. N. C. F. pays the State a rent.

The road. — The roads are paid for by the State and local communities in every country. It may be considered that the costs in question are paid for totally or to a greater or lesser extent by the road licences and taxes on fuel. However, it does not appear thtat the States have tried to make any systematic balance between revenue and the cost of road traffic. Such calculations would be very difficult to make : the taxes and charges are founded upon the principle of the universality of the tax, and the costs are assumed by the State and local authorities, organisations who keep administrative accounts.

An inquiry held in Switzerland showed that about 2/3rds of the costs are covered by the taxes on road transport. In France, where it is considered that equilibrium is possible, the very pertinent question is asked whether the system now in force shares the costs fairly between the different vehicles according to the amount of wear they cause to the roads. Current opinion is that heavy vehicles are not sufficiently taxed having regard to the taxes upon tourist coaches and petrol lorries.

Waterways. — The States generally pay for the making and maintaining of the canals without any contributions from users other than pratically symbolical ones.

Burdens as a public utility.

Official approval (homologation) and publication of tariffs.

We will not go into again tariff obligations such as their official approval and publication, nor into the burden due to reduced tariffs imposed by the State, generally only upon the railway.

Obligation to operate.

Only regular passenger services in general and railway freight service are subject to this obligation. If the concession-holder of a regular passenger road service is subject to it, it should be admitted that before asking for the concession, he would have been able to make the necessary economic calculations and that he has freely accepted the risks of operating.

This is not so in the case of the railways where the obligation covers the whole of the system, a heritage which

often includes many lines which show a deficit. The transfer of the traffic from these lines to more productive lines or a road service cannot take place without the assent of the legislator. Political interference often puts a considerable brake upon the rational reorganisation of the operating of the railway.

Obligation to carry.

The road firms are not subject to this obligation and usually select their clients in two degrees. Clients are first of all picked out according to their importance, the regularity of their production, the kind of goods to be carried (specific weight, ease or difficulty of handling, risks due to their fragility, etc.); then consignments to suitable destinations (those enabling the maximum possible use to be made of the capacity of the lorry) are selected, consignments to scattered destinations being left to the railways, who are obliged to transport them.

Consequently, the Railway Administrations are obliged to serve zones where there is very little traffic, and carry all the consignments rejected by their competitors.

In addition, they are the only ones who have to cope with peak traffic or extra traffic due to breakdowns, even if these lie outside their commercial interests.

Equality of treatment for all users.

We have already examined earlier on the traditional character of this obligation which in the case of the tariff is imposed in a one sided manner upon the railways. Though from the point of view of the rates to be granted, it is completely contrary to commercial principles, it must be stressed that it also extends to the supplying of rolling stock, to transit times and the responsibility of the carrier.

In their replies to our questionnaire, the Indonesian Railways also make a point of the fact that the Administrations apply standard national rates over the whole of the system whereas the prime cost on the different lines varies according to the density of the traffic and operating difficulties.

* * *

We have already been able to report in this paper that in certain countries these obligations have been reduced as far as the railway is concerned.

The most striking reform is that departing from the homologation, the publication of the tariffs and the equality of treatment of all users by allowing the Administrations to make private contracts (Holland and Denmark).

The burden of wages, social security, retirement and survival.

It is generally admitted that there are certain differences between the salaries and social benefits granted by the Railway Administrations and those granted by the road and water firms.

As a result there is a difference in the average cost of the working-hour for the different methods of transport which the social evolution is tending to equalise.

As far as indirect wages costs are concerned, the Administrations insist above all on the question of the cost of retirements and pensions.

In the case of private firms, national legislations generally provide for the provision of superannuation funds based either on the principle of capitalization or on that of sharing (répartition). They are paid for by deductions from wages in proportion to the amount earned and paid for partly by the employer and partly by the employees. As in most cases, whether for the time being or permanently, these funds are insufficient to pay for the whole amount of the pensions, the State has to intervene and help out.

On the other hand, the railways have their own superannuation funds and if

necessary assure the finance of these charges by an allocation from the operating account.

The mathematical reserves to be set aside are so much greater, in proportion to the wages paid, as the number of employees is much lower than it was 25 years ago.

To sum up, we find on the one hand that the State intervenes in the case of wages other than those paid by the railway, that the competing firms pay contributions exactly according to the number of their employees, whereas on the other hand the Railway Administrations have to support a burden completely out of proportion to the staff charges imposed on other industries.

IX. INTERVENTION OF THE RAILWAYS IN TRANSPORT CARRIED OUT OTHERWISE THAN BY RAIL.

In view, on the one hand, of the disparity between the burdens laid on it and the unfortunate position of the railway that results therefrom, and, on the other hand, to the technical value of each method of transport, the Railway Administrations, within the legal limits allowed them, have made use of road transport.

The objects in view have been the transfer of passenger traffic from lines showing a deficit and the realisation of door to door services in the case of freight traffic.

In France, the S. N. C. F. by means of associated companies shares in various passenger road transport services, lorry services, grouped services, container and terminal services. The rates applicable to these ventures have to be approved by the Ministry of Public Works.

In Belgium, the regular passenger road services, which we have already mentioned, are of two types :

— supplementary services to the railway services;

— services replacing the railway services.

The system used tends to make the S. N. C. B. stand all the financial risks of such services by paying the private concession holders on the basis of a formula of the costs, taking into account the characteristics of the working and by cashing the whole of the receipts.

The S. N. C. B. operates its own road services for door to door goods services. On the other hand, it is not allowed so far to work freight services from one town to another.

In Holland, 48 % of the interurban passenger road services are operated by associate companies of the N. S. These same companies also carry out all types of occasional transport which can be worked by a private firm. The rates for the regular services are based upon the costs and approved by the Minister of Transport.

A single associated company deals with the freight traffic and assures the following services :

— door to door services;

— operation of its own lorry services;

— international services;

— occasional transport.

The N. S. also holds shares in a water transport firm.

In Denmark, the railways run a large number of motor services under the same conditions as those imposed on other private firms. They also operate many maritime lines (ferry-boats and others) which are considered to be an integral part of the railway system owing to the geographical conformation of Denmark.

In Switzerland, the C. F. F. operate water services on the lakes which are covered by the same obligations as those on the railway. They also work certain terminal services and have an experimental road haulage service.

In Spain, the RENFE assures regular passenger services through private firms.

The door to door services are also worked through private firms.

In Finland, the railways own the majority of shares in two road transport firms who assure the terminal services or supplementary services. These are run under the same rates and conditions as other road transport firms.

X. LOCALISATION OF THE RAILWAY DEFICIT.

The sole object of the present chapter is to throw light upon a certain tendency which is sufficiently general to attract attention. The object of the tariff policy should be to attain not only a balanced budget as a whole, but to assure the profitability of both the passenger and freight services. In most countries, however, the deficit shown by the passenger traffic is more marked than that of the freight traffic.

This state of affairs appears to be in part attributable to the greater opposition by the State, for political reasons, to requests to increase the passenger fares in certain cases.

In Portugal, the tariff system does not appear to cover the costs in the case of either the passenger nor the freight services. The causes are the social tariffs which affect 80 % of the passengers, the reduced value of the freight traffic and the amount of traffic in general.

In Spain, the passenger deficit is definitely greater than the freight deficit. The causes of the deficit are essentially the too low rates and State taxes.

In Switzerland and Finland, the cause of the deficit is estimated to be the absence of sufficient freight traffic to cover the fixed costs now charged up to the passenger traffic. The passenger traffic, which shows the greatest deficit, is the stopping trains and suburban services.

In France, the two categories of traffic, passenger and freight, would show a profit if only the direct costs were taken into account. If the common expenses divided up between the two according to certain standards are taken into account, there is a deficit.

This deficit is attributed to the chaotic competitive state of the transport market which leads to price reductions which economically cannot be justified.

In Belgium, the freight traffic shows a profit which makes up to a certain extent for the loss on the passenger traffic. The latter is due essentially to the burdens imposed on the railway and abnormal costs which cannot be attributed to the working and are not entirely made up by the Government. If the passenger traffic could balance its finances, the S. N. C. B. could adjust its freight rates and improve their competitive value.

The Cameroons, Belgian Congo, Madagascar and Indonesian Railways also show a greater loss in the case of the passenger traffic than the freight traffic, chiefly on account of the small amount of traffic and average financial standing of the population.

XI. EFFECTS OF TECHNICAL PROGRESS UPON THE TARIFFS.

The effects of technical progress are determined by an optimum rhythm of investments in industry in general.

Consequently, productivity tends to increase in the long term according to a cumulate processus : the cost per unit of service diminishes correlatively.

With a liberal economy, as with a planned economy, technical progress constantly increases the margin of « services available » and constantly reduces the « economic » cost of these services whether estimated in francs or in hours of work.

We do not think that this theory is completely fulfilled in the case of railway technique.

Like all sections of industry, the railway, in spite of the capital investment

required, follows up technical progress. We do not think there is any need to go into the advantages conferred by electrification, by dieselisation, by the rationalisation of the operating and administrative structure of the railway, but we can state that the most important element in the cost « direct and indirect wages » does not decrease as a function of the theoretical speed with which technical progress will increase the availability of labour. This results, on the one hand, from the stability of employment which the staff enjoy and, on the other, the fact that the traffic — owing to the obligations imposed upon railway undertakings — cannot progress as a function of the possibilities offered.

In France, the present rhythm of capital investments allows of a constant reduction of the expenses from one year to the next (4 to 5 million thousand French francs a year). This phenomenon exists to a varying degree on most railway systems.

However, each improvement cannot give rise to immediate results from the economic point of view of labour costs. On the other hand, it happens that during a period of low productivity there will be falling off in railway traffic which, owing to the competitive conditions at such a period may be relatively greater than the overall falling off in production; in this case, the economies realised by the technical impovements will only have helped towards putting a brake on the average rise in the cost of the ton-kilometre due to the fact that certain expenses cannot be avoided.

However, one tangible result of the progress made at the present time, is that, within proportional limits, the levels of the rates have not followed such an upward climb as the cost of living in general, and the cost of the factors concerned in the general costs, whereas the operating deficits have been lower on many railways.

We have also noted that certain railways (such as the Cameroons Railways) expect to reduce their rates after the completion of their dieselisation programme, and others (Madagascar) attribute the fact that they have been able to balance their budget to this technique.

In conclusion, we might say that in the case of railway technique, the usefulness and opportunity of an investment dictated by new technical possibilities should not be calculated as a function of the immediate cost per ton-kilometre but rather as a function of a theoretical cost in terms of the unit of production. As for adapting the tariffs as a function of the technique, this can only be fixed exactly within the framework of a normal competitive state of affairs.

XII. EFFECTS OF THE COORDINATION OF TRANSPORT UPON THE EVOLUTION OF THE RATING POLICY OF THE RAILWAYS.

The initial stages of coordination are in fact nothing more than a large scale inventory dealing with the following points :

Cost of the permanent way.

The S. N. C. F. is of the opinion that if all methods of traction were put on an equal footing as regards the cost of the route they use, road costs would be increased by 10 to 15 % which would enable the railways to raise certain tariffs the level of which cannot be justified economically.

The opinions expressed by the greater number of Administrations frequently make the same point : if the road and water ways had to pay the total cost of the routes used by them, the railways would be able to adjust many of their tariffs.

Other railways, in particular the Portuguese Railways put forward a different formula : « Let the State take over the cost of maintaining the routes used by all methods of transport. »

Under such a hypothesis, the effects upon the railway tariff system would also be striking.

* * *

In practice, the first formula makes the clients pay for the cost of the route used through the tariffs. The second formula makes the community pay for these costs through taxation, as the State would collect all or part of the money it has to spend in the form of taxes.

Taxation costs.

In general, the railways enjoy a reduction of 50 % in transport taxes compared with their competitors.

In so far as it is desired to do away with all discrimination, it must be admitted that there should also be equality on this point.

As far as the duties on fuel are concerned, these could no longer be considered as balanced by the privilege of using the infrastructure.

Costs of public services.

Although various Railway Administrations claim the right to manage their undertakings as an industry, they are generally of the opinion that in the interest of the community it will always be necessary for them to bear at least a minimum of the costs involved in being a public service, viz. :

— official approval (homologation) and publication of the maximum tariffs, with the reserve that they shall have the liberty to make special agreements which do not have to be published (system now used in Holland);

— obligation to operate provided that, to give an equivalent service, they are free to choose what technique they will use;

— obligation to carry in so far as it is conceded that at peak periods or during breakdowns, the delays in supplying rolling stock and transit times can be increased and precedence can be given to clients who are valuable from the business point of view.

Apart from these points, like any other method of transport, the railways incline towards a system of tariff freedom, with the sole condition that they respect the maximum general published tariffs, the essential object of the tariff policy remaining the balancing of the budget. This situation is moreover in every respect that in existence in Holland and the financial results of the N. S. make it possible to appreciate the value of this doctrine.

It is true that the application of such a system, in most countries, would be somewhat complicated by the existence of tariffs of a social and economic nature imposed by the State. This raises the problem of the transition measures that will be necessary.

Working conditions, wages, social benefits, pension costs.

A greater control of the enforcement of the law on working hours appears desirable in certain countries.

The relative level of wages in the various methods of transport is a difficult problem which is in need of attention.

As regards social benefits, the same remarks apply in the case of certain countries.

* * *

Though it must be recognised that efforts have been made in many countries in the particularly difficult field of the co-ordination of transport, it is quite obvious that the measures introduced are a long way from being recognised by the railways as effective in the general interest.

In many countries, the position has become so complicated that the Governments are obliged to use corrective measures sporadically, and also others of an opportunist nature. Owing to this fact, very few railways are able to put forward a policy for the future as far as the tariffs are concerned.

The French Regulations of 1949

attracted our attention owing to the fact that they seem to cover the whole of the problem.

The doctrine we find is as follows :

a) assure that clients' requirements are met;

b) in the most advantageous way for the economy of the country;

c) by using that method of transport which, taking into account the value of the services and obligations imposed, gives the minimum production costs.

We must point out, on the other hand, that in the case of Switzerland, the State has decided in favour of free competition.

XIII. PROBABLE EVOLUTION OF RAILWAY TARIFFS.

Within the framework of evolution, subordinated to ideas of co-ordination, even limited to the single objective of equality of treatment, it appears from the opinions expressed that it is possible to foresee for the railways a tariff policy for the future more and more based upon the idea of the cost and intended to maintain and if possible develop essential traffic.

Under present conditions, tariff reforms seem rather to have the character of measures of conservation rather than structural reforms.

Passengers :

The use of two classes appears to be becoming general in most countries.

Small consignments of freight :

Two tendencies are noted :

a) Netherlands system : handing over the traffic to associated companies, the railway merely forwarding the loaded wagons which are made up into trains in their yards;

b) continuing to operate the traffic by rail, the railway in order to retain its ground in the face of competition doing all it can to get commercial flexibility equal to that of its competitors.

The first measure already introduced in most countries is to do away with « ad valorem » classes and adopt two speeds « express » and « high speed ».

The second measure is aimed at giving clients fixed prices for services including the supplementary cost of door to door collection and delivery.

In France and Belgium, the cost of door to door collection and delivery is included in the scale of charges. In Belgium, there is a difference in the rates according to the cost of these services for different points of acceptance and delivery.

An extended use of fixed rates per kilogramme of freight per zones of distance is seen as a subsidiary development.

Full loads :

It seems that the use of the « ad valorem » tariff formulae should be limited entirely to occasional traffic, organised traffic often being included within the framework of special tariffs based on the actual costs.

The usefulness of many classes is disappearing. The « ad valorem » rates are evolving towards maximum rates of general application.

The regressive reductions in the general scales of rates are evolving towards corrections which correspond more truly with the laws of the cost prices involved.

In the field of organised traffic, the general policy always tends towards the objective of balancing the budget, the cost of transport evolves between the extreme limits of the total and marginal cost prices.

* * *

The railways express themselves more or less vigorously on the subject of having to publish certain tariffs. The wish has been expressed that the railway should be freed from the obligation of publishing them to the extent that such an obligation does not also fall upon other methods of transport. Oher railways stress the system of maximum and minimum rates.

* * *

CONCLUSIONS.

In this report, we have endeavoured essentially to present according to the documentation submitted a descriptive review of railway tariffs, of the economic framework within which they have evolved, and the effects of competition from other methods of transport. This latter point has led us to analyse the causes at the bottom of the disparity between the competitive strength of the railway, waterway, and road. And imperceptibly it became apparent that the endeavour to attain co-ordination raises in particular the serious problem of doing away with the different treatments accorded to the different methods of transport.

Moreover, the character of public service belonging to railway transport profoundly affects its tariff system. From this fact, in the continuous development of general traffic due to the economic evolution, the railway cannot enjoy its fair share, to the extent that would be made possible if tariffs of a purely commercial value could be applied.

The evolution of the tariff policy will depend very closely upon the views of the Governments regarding the possibility of liberating the railways from the burdens of a public service or giving them adequate compensation therefore.

If a system of equality between the different methods of transport was introduced and a suitable alteration in the burdens of being a public service, the problem of the evolution of railway tariffs would find itself essentially linked up with industrial ideas of the question of prime costs.

[621 .431 .72]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(THE HAGUE-SCHEVENINGEN, 1956.)

QUESTION 2.

In a system of standard, narrow or broad gauge lines which has Diesel traction for shunting and for main line working, what are the conditions governing :

1) the choice of the characteristics and kind of transmission ;

2) the most economical organisation, maintenance and operation.

Research into savings that might be possible in comparison with steam traction.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and dependen overseas territories),

by R.F. HARVEY,
Chief Operating and Motive Power Officer, British Transport Commission.

FOREWORD.

Question — *In order to obtain a better idea of the existing situation in regard to dieselization, we have considered it advisable to request each administration to which a questionnaire is sent, to be good enough, firstly, to reply to the two initial questions, as follows :*

1. — a) *Number of Diesel locomotives in normal service, on trial, or under examination according to the type of service operated :*
   — *shunting;*
   — *train working (passenger, freight, mixed traffic);*
   — *mixed service (train haulage and shunting).*

   b) *What are the essential characteristics of the principal types of these various locomotives :*
   — *type;*
   — *weight per axle;*
   — *method of transmission;*
   — *maximum speed;*
   — *tractive effort/speed curve;*
   — *number of Diesel motors;*
   — *nominal power and speed of traction motor/motors ?*

2. — *Brief summary of the characteristics of the system, or part of system, over which the service is operated entirely or partially by Diesel:*
a) *structure (gauge, weight of rail, track characteristics);*
b) *gradient profile;*
c) *nature and intensity of traffic;*
d) *characteristics of shunting services.*

NOTE.

The figures shown in the replies from the various Administrations on items 1 (a), 1 (b) and 2 of the questionnaire are rather difficult to follow on the statement, and I have therefore endeavoured to show the approximate totals under these headings at the beginning of this report. If details of the equipment on any of the railways concerned are required, reference will be necessary to the itemised details on the main statement.

1. — a) *Total number of locomotives in service.*

Shunting	9 050
Train hauling	7 906
Mixed traffic	903

Total number of locomotives on building programme.

Shunting	435
Train hauling	277
Mixed traffic	6

1. — b) *Characteristics of particular types of locomotives.*

Shunting	0-4-0, 0-6-0, Bo-Bo, 1.B.B.1.
Train hauling	A1A-A1A, Bo-Bo, Co-Co, 1Co-Co-1, 2Co-Co2, 1-C-1.
Mixed traffic	Bo-Bo.

Axle weights.

Shunting	0-4-0	varies 10 t. 8 c. to 16 t.
	0-6-0	» 9 t. 10 c. » 17 t. 13 c.
	Bo-Bo	» 5 t. 15 c. » 26 t. 15 c.
Train hauling	A1A-A1A	» 12 t. 0 c. » 18 t. 5 c.
	Bo-Bo	» 12 t. 15 c. » 20 t.
	Co-Co	» 14 t. 5 c. » 28 t. 16 c.
	1Co-Co1	18 t. 10 c.
	2Co-Co2	11 t. 5 c.
	1-C-1	9 t. 3 c.
Mixed traffic	Bo-Bo	varies 13 t. 0 c. to 20 t. 5 c.

Method of transmission.

Shunting	0-4-0	Mech., Hyd., Elec.
	0-6-0	Mech., Elec.
	Bo-Bo	Mech., Elec.
	1.B.B.1	Hyd.
Train hauling	A1A-A1A	Elec.
	Bo-Bo	Elec.
	Co-Co	Elec.
	1Co-Co1	Elec.
	2Co-Co2	Elec.
	1-C-1	Hyd.
Mixed traffic	Bo-Bo	Elec.

Maximum speed (m.p.h.).

Shunting	0-4-0	varies 12 to 18
	0-6-0	» 20 » 30.5
	Bo-Bo	» 32 » 65
	1.B.B.1	100 km/h.
Train hauling	A1A-A1A	varies 55 to 75
	Bo-Bo	» 55 » 70
	Co-Co	» 70 » 117
	1Co-Co1	85
	2Co-Co2	60
	1-C-1	30
Mixed traffic	Bo-Bo	57

Tractive effort (lbs.).

Shunting	0-4-0	varies 10 800 to 21 500	
	0-6-0	» 16 850 » 35 000	
	Bo-Bo	» 25 000 » 78 750	
Train hauling	A1A-A1A	» 28 900 » 46 000	
	Bo-Bo	» 13 900 » 34 500	
	Co-Co	» 41 400 » 76 600	(on building programme)
	1Co-Co1	» 48 000 » 50 000	
	2Co-Co2	48 900	
	1-C-1	20 150	
Mixed traffic	Bo-Bo	22 800	

Number of Diesel engines.

Normally one engine per locomotive is fitted; the exceptions are: « The Fell » on British Railways, which has four main engines driving to the central gearbox, and D11 class in Japan, D1 class in Norway, and a Bo-Bo type in New South Wales which is fitted with two engines.

Horse power (HP).

Shunting	0-4-0	varies from 88 to 200	
	0-6-0	» » 200 » 350	
	Bo-Bo	» » 800 upwards	
	1.B.B.1	2 000	
Train hauling	A1A-A1A	varies from 750 to 1 600	(where quoted)
	Bo-Bo	» » 800 upwards	
	Co-Co	» » 1 600 »	
	1Co-Co1	» » 1 750 to 2 000	
Mixed traffic	Bo-Bo	1 000	

Nominal power of traction motors (HP).

Shunting	0-6-0	270
	Bo-Bo	varies from 380 to 492 (in U. S. A. — 600 V. variable speed and required gear ratio in areas in which operating)
Train hauling	A1A-A1A	varies from 520 to 1 600
	Bo-Bo	» » 460 » 620
	Co-Co	1 068
	1Co-Co1	varies from 1 212 to 1 380
	2Co-Co2	1 050
Mixed traffic	Bo-Bo	700

Speed of traction motors.

Varies widely; dependent on gear ratio required and particular make of traction motor fitted (see statement for details).

2. — *Brief summary of characteristics of systems.*

Gauge :

4′ 8 ½″	British Railways : U. S. A.
3′ 6″	New Zealand : East Africa : Nigeria : Norway : Japan
2′ 6″ and 5′ 6″	Ceylon
5′ 3″	Republic of Ireland

Weight of rail (lbs. per yard).

4′ 8 ½″	gauge :	
	British Railways	85- 95 (bullhead)
		98-109 (flat bottom)
	U. S. A.	100-155
3′ 6″	gauge :	
	New Zealand	70-100
	Nigeria	60
	Norway	35 kg/M
	Japan	37 kg/M and 50 kg/M
5′ 6″	gauge :	
	Ceylon	72-90
5′ 3″	gauge :	
	Republic of Ireland	70-90

Gradient profile.

4′ 8 ½″	gauge :	
(*)	British Railways	level to 1/70
	U. S. A.	approximately 0.5 % to 3.5 %
3′ 6″	gauge :	
	New Zealand	maximum 1/41
	Nigeria	1.25 %
	Norway	19 mm/m
	Japan	level to 2.5 %
5′ 6″	gauge :	
	Ceylon	maximum 1/44
5′ 3″	gauge	
	Republic of Ireland	main line, 1/60
		branch line, 1/50

(*) The steepest gradient on British Railways is 1/37 between Bromsgrove, and Bournville, but at the present time Diesel locomotives have not yet worked over this section of the line.

Track characteristics.

In general, rails are supported on chairs or base plates attached to wooden sleepers. The distance at which the sleepers are set depends upon the type of terrain.

On British Railways concrete sleepers spaced 24 to each 60 ft. rail length are in use on certain subsidiary lines as an experiment.

Steel sleepers are used in Nigeria on account of the climatic and pestiforous conditions.

Ballast is either crushed stone, crushed metal ballast or slag, and the depth varies according to the terrain formation.

Nature and intensity of traffic.

The nature and intensity of traffic varies, and is governed by the economic development of the country.

Characteristics of shunting services.

Shunting locomotives are employed in flat, gravity and hump yards. In some cases they are used for shunting within station limits and the smaller types work in docks and goods sheds.

CHOICE OF CHARACTERISTICS.

A. Train hauling.

Question 1. — *If the operation of a district calls for a high degree of power, do you prefer high power locomotives or do you consider it more advantageous to use lower power locomotives coupled together? For what reasons?*

1. — British Railways :

A single locomotive of given power is generally cheaper in first cost than two separate locomotives each of half the power. Multitple-unit working may be resorted to if necessary.

U. S. A., Norway, Japan :

Prefer high powered locomotives, resulting in fewer locomotives and thus lower overall maintenance costs, also prevents loss of time in coupling and uncoupling.

New Zealand, Nigeria :

Prefer medium or low powered locomotives which are most adaptable to varying conditions of track, etc... In the case of Nigeria if one unit, of two working in multiple fails, the train can continue to be worked by the remaining unit.

Republic of Ireland :

Working with medium powered locomotives which are not as yet running in multiple.

Ceylon :

Prefer high powered locomotives for heavy haulage on level road but consider low powered locomotives coupled together are best where heavy gradients are encountered. This question resolves itself into :

a) the length of time the maximum tractive effort is required;

b) the maximum axle weight allowed on sections concerned.

Question 2. — *If you favour the principle of using coupled locomotives, do you consider that there should be corridor connection between the two units? If so, for what reasons?*

2. — There is an equal division of opinion on the question of gangway connections. The Ceylon, Japan, Norway and Republic of Ireland administrations do not consider them necessary. British Railways, New Zealand, U. S. A. and Nigeria favour their provision so that access may be obtained to the power unit and equipment when running, for periodical inspections and to give attention to the steam heating boiler where fitted on the locomotive. Also of great assistance in the event of fire.

Question 3. — *Are certain of your locomotives made up of several units? Do you envisage the possible use of such locomotives?*

3. — The U. S. A. is the only country at present where locomotives are made up of several units for service. The

possible introduction of this practice is envisaged by all other Administrations except that of Ireland.

Question 4. — *Do you consider that a single type of locomotive could, satisfactorily, cope with a varying range of gradients, loads and speeds in the haulage of different categories of trains; if not, how many types do you consider should be constructed :*

a) *for main lines?*

b) *for secondary lines?*

What do you consider should be their power?

How do you justify your choice?

4. — It is not considered that a single type of locomotive could satisfactorily cope with the requirements, either for main-line or secondary line working. The choice of the undermentioned types is governed by the variation between countries of :

1) the nature of traffic;

2) limitation on axle weights.

The general selection is as follows :

Main-line services :

Single unit locomotives of from 1 000-3 600 HP working in multiple if required.

Secondary services :

Locomotives of from 750 to 1 700 HP.

Shunting :

Locomotives of from 350 HP upwards, apart from small units of 200 HP.

Question 5. — *Are your Diesel locomotives used both for passenger and freight services? If so, what is gained by this combination of duties?*

5. — With the exception of East Africa who have no passenger locomotives and New Zealand where express passenger services are exclusively worked by a modern fleet of steam locomotives, all Administrations have Diesel locomotives which can be used on both passenger and freight services. This results in a higher availability of locomotives. Spare parts are also kept to a minimum.

Question 6. — *How do you propose overcoming the problem of heating in the case of Diesel locomotives operating a passenger service? What reasons have you for this preference? Is the system installed on the locomotives or on a special vehicle?*

6. — The problem of train heating where Diesel locomotives haul passenger trains is one of the most difficult requiring solution. Various methods are employed. British Railways and the railways of U. S. A. and Japan have steam heating boilers fitted on the locomotive and these are tended by the fireman or second driver. In Norway and the Republic of Ireland, steam heating boilers are carried in a special vehicle which is attached to the train as required. New Zealand would adopt this method should passenger train hauling be dieselised. This latter system has disadvantages, one being that if a train is divided at a junction two heating vans have to be provided. British Railways have examined this method and decided against it; the ultimate policy is heating by electricity supplied from the locomotive, either from its own power unit or from a separate Diesel generator.

The question of providing generating sets is under consideration by Norway in view of their proposed electrification. In the event of a failure on a mountain line, the special heating equipment would remain in service until such time as the locomotive could be replaced. This would also apply should the power supply fail on the electrified lines.

B. Shunting services.

Question 7. — *What, in your opinion, should be the power of Diesel locomotives for the various types of shunting*

to be performed : breaking down of trains by the gravity/hump method — work in sidings — transfer of sets of wagons — shunting at small stations, warehouses, workshops or depots ?

7. — With the exception of the U. S. A., and excluding locomotives under 200 HP, the power required for shunting services is between 350 HP and 600 HP. In the U. S. A. the average power required is 1 000-1 600 HP.

Question 8. — *On the basis of these considerations, how many classes of locomotives are provided or will be provided for shunting and what are their essential characteristics ?*

8. — Including small types of locomotives of 200 HP, the number of different classes required for shunting by the different Administrations varies from two to six.

C. All Services (train hauling and shunting).

Question 10. — *What factors do you think should be taken into consideration when selecting the scope of operation or the period of transition for Diesel locomotion ?*

10. — Sufficient power within the axle load limits permitted over the section of line concerned.

Greater economies that can be obtained from Diesel traction, arising from higher utilisation.

The rate at which steam locomotives can be economically disposed of.

The financial considerations of the Administration concerned.

Where electrification is contemplated, the rate of progress of the scheme.

The average train weight required to be hauled.

The time taken to train operating and maintenance staff.

Question 11. — *What axle arrangements have you adopted or do you propose adopting for :*

a) *train haulage on main lines;*

b) *shunting.*

Have these arrangements been influenced by the general characteristics of the track structure ?

What factor or what axle arrangements ensures economy in track maintenance ?

11. — The axle arrangements vary considerably. The following are most widely employed :

Train hauling, Main lines, 1Co-Co1, Co-Co, Bo-Bo, A1A-A1A;

Shunting, 0-4-0, 0-6-0, Bo-Bo (East Africa contemplate 6 and 8-coupled arrangements).

Choice of axle arrangements has been influenced by the general characteristics of track and tractive effort required on the railways of Britain, East Africa, Norway and Republic of Ireland, but this is not necessarily so elsewhere.

There is no data available in this report as to what axle arrangements ensure economy in track maintenance. U. S. A. state that, with light rails 6-wheeled trucks (Co-Co type) are most favourable to the track structure. As against this Japan favour the Bo-Bo type, but as yet their experience is limited.

Question 12. — *For secondary lines, do you consider it necessary or desirable to specialise in locomotives for train haulage and others for shunting; for what reasons ?*

12. — It is generally considered that it is not desirable to specialise in locomotives for train haulage and others for shunting, on secondary lines. However, there are exceptions to this view. The Republic of Ireland, for example, do advocate on minor branch lines a small 0-4-0 or 0-6-0 locomotive for financial reasons. New Zealand are of the opinion that where

the volume of traffic is heavy the provision of a shunting locomotive at certain points may be warranted. British Railways consider that a secondary line Diesel locomotive which is suitable for mixed traffic working is desirable.

Question 13. — *Do you favour the greatest possible degree of standardisation by using only the lowest possible number of types of Diesel locomotives and engines?*

13. — Yes. Standard types are desirable with interchangeable connections and couplings as far as this can be achieved.

Question 14. — *In the case of a particular locomotive, do you think it preferable to use a single engine or several engines of lower power?*

What are the reasons for your answer, taking into consideration the cost of construction, maintenance costs and possible adverse effect on operating reliability?

What type of engine do you prefer — slow or fast — (two stroke or four stroke)?

14. — A single engine is preferable to several engines of lower power, as this is more economical from first cost and maintenance costs point of view.

There is considerable difference of opinion as to the relative merits of the two-stroke or four-stroke (slow or fast) types of engines. U. S. A. prefer the two-stroke type. New Zealand, at the moment, prefer slow to fast engines. Ireland say it is too early to express an opinion although they have two-stroke slow speed, four-stroke slow speed and four-stroke high speed engines in service. East Africa and Nigeria support a medium speed four-stroke engine as this is more robust than the small high speed type. Norway's limited experience indicates that high speed engines are more robust in service. British Railways have had little experience of two-stroke engines but it is considered that the four-stroke slow or fast running type of engine is preferable, depending on axle weight and route availability requirements.

Question 15. — *Do you consider it expedient to investigate the use of lower efficiency Diesel engines which are more simple, less costly, do not require a high standard of maintenance labour or such frequent workshop attention, but which is offset by a lower degree of engine performance?*

— *have you had any experience in this connection?*

— *have you investigated construction methods that would allow the maximum possible facilities in maintenance by the standard exchange of engine parts, also the standardisation of a large number of component parts (pumps — injectors — self-starters — compressors — radiators — brakes — lighting equipment...).*

15. — In general it is not considered expedient to investigate the use of a lower efficiency Diesel engine but it is interesting to note the remarks of New Zealand on the subject. They state that the more efficient engine would naturally be preferred but on their system precedence will be given to reliability and low maintenance costs. Any savings in fuel costs that might be achieved could easily be offset by increased capital and maintenance costs, apart from indirect costs incurred as a result of traffic hold-ups.

Construction methods that would allow for standardisation of engine parts and component parts have not been investigated to any great extent. It is considered, however, by British Railways that as far as possible components should be interchangeable between different types of locomotives, viz. fuel pumps, fuel injectors, self-starters, etc...

Question 16. — *On Diesel locomotives, do you advocate the installation of a single driving cabin in the centre, or a cabin at each end, or a single cabin only at one end :*

— for shunting locomotives;

— for locomotives hauling trains.

16. — Shunting locomotives — single cab at one end preferred by all Administrations but Ceylon and Japan favour single cab in centre on two-engine locomotives.

Train hauling locomotives — with the exception of U. S. A. where cab at one end is preferred, most working being with multiple unit, a cab at both ends is considered necessary.

Question 17. — *Do you favour the use of the « dead man's handle » :*

— for shunting services;

— for train haulage services.

17. — Provision of a « deadman's device » for all services is favoured by all Administrations except U. S. A., Japan and Ceylon. The U. S. A. do not consider it necessary on shunting locomotives, and Japan state it is not required on any locomotive because their drivers are always accompanied by an Assistant Driver.

Question 18. — *What type of fire fighting equipment do you favour for Diesel locomotives? Portable or fixed, automatic or remote control extinguishers — type of chemical used, gas, foam... etc.).*

18. — Ceylon, Japan, U. S. A., Norway and Ireland favour portable type extinguishers. Remaining Administrations prefer automatic or remote-controlled equipment in addition to portable extinguishers kept in the cab for use by the driver.

METHODS OF TRANSMISSION.

Question 20. — *In the light of your experience and in all investigations made by your administration, what, in your opinion, are the respective fields of use for the various methods of transmission, mechanical, hydro-mechanical, hydraulic and electric? What are their advantages and disadvantages as regards :*

— efficiency in transmitting the different degrees of power actually produced;

— weight, size;

— initial cost and maintenance costs;

— ease of driving the locomotive;

— efficiency;

— operating reliability;

— what difference does the power of the engine make to your conclusions?

20. — General opinion is that for the higher powered locomotives electric transmission is most satisfactory, although this type is heavier than hydraulic.

It would seem there has been insufficient experience to enable the relative merits of mechanical and hydraulic transmission on comparable types of locomotives to be assessed. For instance, in the U. S. A. hydraulic drives have only been used on experimental locomotives, and in other countries, with the possible exception of the « Fell » (2 000 HP Diesel Mechanical 4-8-4) on British Railways, mechanical and hydraulic transmissions have only been applied to units of relatively low horse-power.

Question 21. — *In the case of mechanical, hydro-mechanical or hydraulic transmission, what system of axle drive do you favour in the light of your experience :*

a) *between the output shaft of the gearbox or of the torque converter and the main driving axle?*

b) *between the driving axles, e. g. direct transmission, worm or spiral bevel with connection by means of jackshaft and chains?*

21. — With the exception of Ceylon and Japan, the Jack-shaft drive from the gearbox and the final drive by coupling rods type is preferred. Ceylon use this type on their narrow gauge system but have the cardan shaft drive on the broad gauge lines. Japan use the jack-shaft etc. drive for small shunting locomotives and prefer propellor shaft drive for larger units.

Question 22. — *In the case of electric transmission, what arrangements do you advocate to obtain the best adhesion coefficient, from the point of view of :*

a) *electrical connection of the traction motors if the locomotive has independent axles ?*

b) *mechanical connection between the axles in the alternative case ?*

What are the reasons for your choice, particularly for small power and shunting locomotives ?

22. — Traction motors are usually permanently connected with two motors in series for either main line or shunting locomotives. Parallel connection of motors is preferred where circumstances warrant the additional cost which sometimes occurs. The driving wheels of main-line locomotives are not mechanically connected.

With the exception of Japan and the United States of America, on Diesel shunting locomotives the axles are usually connected mechanically with side coupling rods.

Mechanical coupling has given good results with series connections to traction motors, but the parallel connection has also been used and it is considered that the choice depends on what is the most economical arrangement for providing the required tractive effort appropriate to the speeds and loads.

Question 23. — *Do you consider it possible with all types of transmission, given a good state of wear and maintenance cost, to make continuous use of the total power produced by the Diesel motor for a very extensive range of locomotive speeds ?*

Are these considerations of such a nature as to have a determining influence on the choice of the method of transmission to be adopted ?

23. — The answer to this question is, U. S. A. and Japan consider that it is not possible to make continuous use of the total power produced by the Diesel engine. Ceylon, Norway and Republic of Ireland consider that it is possible. New Zealand Administration state that within the limits of the capacity of the various forms of transmission, all types could utilise full engine power over long periods, but suggest that the hydraulic type would require the provision of a generous heat exchanger capacity to enable them to do this.

On British Railways, so far as transmissions other than electrical are concerned, the answer would appear to be « yes », but this will require to be confirmed by actual experience, particularly in the high power range and seeing that it is not usually possible for a shunting locomotive to be run at full output for a lengthy period.

DEPARTMENTAL ORGANISATION AND OPERATION.

Question 24. — *For which types of locomotives and for what services is driving performed by one or two employees (or more) ?*

Does the second member of the crew have any other duties than those of assisting the driver ? If so, what are they ? What are the resultant economies ?

24. — There is a difference in the number of men utilised on the footplate on Diesel locomotives in the various Administrations and this is shown below :

Country	Main-Line Locomotive	Shunting Locomotive	
British Railways	2	1	(except when working on main-line)
New Zealand	2	1	
Japan, Ceylon, Nigeria . . .	2	2	
East Africa	—	1	
Norway, Republic of Ireland.	1	1	
United States of America . .	1	1	(but on certain railways in the U. S. A. a second man is employed to assist)

The second man on the footplate of Diesel locomotives attends to the steam heating boiler where this is fitted and periodically inspects the Diesel engine and equipment whilst running, in addition to the normal duties of observing the signals and assisting the driver as required.

Question 25. — *To which department (Motive Power or Operating) do the driving staff belong, according to the type or power of the Diesel locomotive, in the particular instance of shunting, or of station to station light goods traffic services?*

25. — With the exception of Japan, East Africa and Nigeria the drivers of Diesel locomotives all belong to the Motive Power Department. In Japan the drivers form part of the Operating Department; in East Africa the drivers are attached to the Chief Mechanical Engineer's Department; in Nigeria drivers are trained from the Operating and Commercial Department there being no Motive Power Department in this Administration.

Question 26. — *How are Diesel locomotive drivers recruited?*

26. — In all Administrations excepting the United States and East Africa the main staff on Diesel locomotives is drawn from the ranks of senior drivers or firemen who have been passed for driving steam locomotives.

In the United States Diesel drivers are promoted from firemen or from the second man who has been acting as Assistant on the Diesel locomotive.

In East Africa some difficulty has been experienced in getting African drivers to adapt themselves to the technique required and it has been necessary in some cases for Diesel locomotive drivers to be recruited from staff operating road vehicles and other internal combustion engined machines, but it is hoped with the conversion to fluid drive and the new Voith type of transmission that they will be able to revert to normal recruitment from the steam locomotive footplate staff.

Question 27. — *Have you established training schools for forming a basic driving and maintenance staff? What are the characteristics of these schools?*

27. — Training schemes have been established on the following Administrations :

British Railways, Ceylon, Norway and the Republic of Ireland. In East Africa there is a school for steam locomotivemen and this is at present being used to assist in training these drivers, but it will be necessary for an additional school when main-line Diesels are introduced on this railway. There are no schools in New Zealand, Japan, U. S. A. and Nigeria, but specially trained Inspectors are used for training the driving staff. In U. S. A. some of the railways and the builders of the

locomotives hold instruction classes on maintenance and their drivers are instructed whilst actually running on the locomotive.

Question 28. — *Where depots only perform day to day maintenance which is of a fairly regular character and does not permit of maintenance staff being diverted to driving duties, how do you maintain, or how do you propose maintaining, the driving of locomotives during the time that regular services are supplemented by peak services?*

28. — Maintenance staff are not used for driving duties by any of the Administrations and a limited number of drivers are held at the Motive Power Depots or terminals for use if needed to cover extra work, illness, men on leave and annual holidays of the driving staff.

Question 29. — *In order to ensure the best use of the staff, does your organisation make provision for drivers to be authorised to drive all the different kinds of Diesel locomotives (also if applicable, electric locomotives when the system is partly electrified)?*

29. — With the exception of Japan, drivers are trained to operate all classes of Diesel units that run over the district concerned. Norway consider it desirable that drivers should be kept as much as possible on the same type of traction stock. Japan only train the men to cover type of unit they would normally be working on.

Question 30. — *Do the driving staff of Diesel locomotives perform their duties over the whole system or are they allocated to certain routes? If over the whole system, are the staff allowed to drive all the various types of Diesel locomotives?*

30. — Drivers are permitted to work trains over any route of which they have acquired knowledge. On some of the Administrations, e. g. U. S. A., the driving staff is assigned to districts, whereas in other cases, e. g. New Zealand and British Railways, the driver may be on the footplate up to a distance of 300 miles or possibly over, passing through a number of districts; these drivers are booked off at the depot, other than their home depot, for rest and suitable hostel accommodation, etc. before returning to their home depot on their return run.

Question 31. — *By what staff is the Diesel locomotive serviced before departure? What are the duties laid down for this servicing?*

31. — With the exception of Japan, the maintenance staff of the Motive Power Department and on Administrations where the Chief Mechanical Engineer's maintenance staff are responsible, attend to the necessary servicing details before departure of the locomotive. The Nigerian Railways in their reply give a list of daily items that are attended to and a brief note of some attention given by the driver before departure. Japan state that an Inspector on a fuel/water tender takes care of the locomotive before the driving staff take over and that the driving staff do a considerable amount of the inspection.

Question 32. — *In the case of low power locomotives being in service at isolated districts situated some distance from the home depot and which perform shunting and short distance runs on low density traffic lines, and where driving duties are performed by staff of the stations in that area, how do you organise :*

a) *driving instruction?*
b) *technical supervision of staff in the performance of driving duties?*
c) *inspection and current maintenance of locomotives?*

Have any particular constructive arrangements been made to ensure maximum simplicity in driving, to reduce daily upkeep to the minimum, and to

ensure maximum periods between visits from depot to the workshop?

To which classes of locomotives has this system been applied?

32. — The terms of this question do not apply to the Administrations with the exception of New Zealand; on small Diesel mechanical shunters stationed in outlying provincial centres, driving instruction, inspection and current maintenance is done by tradesmen who travel out to where the Diesels are located, and in some cases, small repair jobs are often carried out by local motor firms, and the day-to-day supervision of the driver in the execution of his duties is carried out by the Station Master. But it is found that once properly trained, these members of the staff do not require much supervision. On other Administrations the driver is a fully trained individual on the type of unit or units that he would be driving. On British Railways considerable thought has been given to driving instructions for all types of Diesel locomotives, and these are issued to drivers before they take charge of a locomotive or unit during their training period and they retain these instructions for so long as they are in charge of Diesel locomotives. Inspection and current maintenance of these locomotives is carried out at main depots at the periods set for the different examinations that are necessary.

Question 33. — *Has dieselisation enabled you to modify to any extent the method of operation over certain lines?*

As a result of dieselisation, do you consider it possible to improve service conditions because of the inherent capabilities of the Diesel locomotive (self-contained unit, common user, decreased time in preparation and garaging)?

Justifiy your point of view.

33. — The answer to this question is yes, in particular in the U. S. A. — As dieselisation is not yet complete on many of the Administrations it has not been possible to modify to any great extent the method of operation over certain lines.

I would draw attention to the replies to the questionnaire of the New Zealand Government Railways and British Railways on this point. New Zealand are making an endeavour to exploit the ability of the Diesel to make long runs without engine changes, etc. by building up through goods train services between Wellington and Auckland, a distance of 426 miles, and on British Railways on certain sections of the line steam locomotives have been removed and substituted by Diesel multiple-unit trains but not as yet by Diesel locomotives.

Question 35. — *In what way do you think reserves of Diesel locomotives should be provided to cover such matters as traffic peaks, diversions or emergencies?*

What is the normal use of corresponding engines?

35. — With the possible exception of the U. S. A. it is not yet possible to give any figure as to the number or percentage of extra Diesel locomotives which will be required to cover such matter as traffic peaks, diversions or emergencies. The U. S. A. state traffic peaks usually do not develop at all points of a railroad at the same time, therefore, locomotives can be shifted from one district to another to meet traffic requirements.

Question 37. — *What changes have occurred, in relation to the previous method of traction, so far as concerns :*

— *average kilometric distances and the average number of daily hours in the use for locomotives, compared with the total stock (including those available and those out of service) per type of service, i. e. Passenger or Freight. (Please give details where lower power Diesel locomotives have replaced steam);*

— *the availability of shunting locomotives, compared with total stock (including those available and those out of service)?*

37. — All Administrations are not in a position to answer this question and I give particulars as far as available for British Railways, New Zealand Government Railways and East African Railways :

British Railways established that approximately 50 % more work can be done by Diesel shunting locomotives compared with steam shunting locomotives per 24 hours.

Availability by Diesel shunting locomotives	91 %
Availability by steam shunting locomotives	90 %

New Zealand. — The average distance run per annum is as follows :

Steam Locomotives	71 000 km
Diesel Electric Locomotives	93 700 km

East African Railways. — Availability of shunting locomotives, i. e. all the Diesel stock, is as follows :

Kenya/Uganda Lines	77.53 %
Tanganyika Central Line	70.77 %
Tanganyika Southern Province Line	67.79 %
Average	70.89 %

The U. S. A. do not give any figures but make the statement that the Diesel locomotive has much higher availability than the steam locomotive because of less maintenance and shopping for boiler attention in this type of power.

Question 38. — *Where you have had occasion completely to substitute Diesel for steam traction in a large shunting yard, what was the required number of steam locomotives, what is the number of Diesel locomotives with which you have been able to maintain the same service and what is the total number of shunting hours before and after dieselisation (these locomotive statistics should be shown both to include and to exclude locomotives out of service).*

How have staff statistics altered (salaried and wages grades) ?

38. — The only figures available on British Railways in answer to this question are those that I have submitted, which are as follows and cover Toton Marshalling Yard :

	Booked	*Spares*	*Total*
1) Number of steam locomotives (including spares) required	14	4	18
2) Number of Diesel locomotives now employed (including spares)	10	2	12
	Hours per week		
3) Total number of shunting :			
a) before dieselisation	1 850		
b) after dieselisation	1 515		
4) Alterations in :			
a) Salaried Grades — Nil			
b) Wages Grades — 34 Firemen			

Since the time when steam engines were booked to perform all the shunting at Toton there have been considerable changes in the work at Toton Sidings due to the modernisation of this marshalling yard. The reduction in the shunting hours per week cannot be said to be entirely due to dieselisation.

In the U. S. A. salary and wages grades have been affected only slightly by the use of Diesel power.

MAINTENANCE.

Question 39. — *What factor do you take as a basis for determining the frequency of inspections and periodic overhauls of Diesel locomotives? Is the basis of examination carried out on mileage, number of running hours, number of operating days, etc.?*

State the reasons for your preference.

In particular, in connection with Diesel engine maintenance, do you consider that it is preferable to relate the examination to the characteristics of the engine itself and base it on such factors as : oil analysis, spectrographic examination of oil, rate of compression, unit consumption of oil, etc...)?

39. — Examinations are carried out either on a daily or mileage basis or periodically and engine hour basis and the procedure on the various Administrations are shown briefly hereon :

British Railways. — Daily and mileage basis, excepting a 10 — 15 day examination necessary on Diesel shunting locomotives, in order that they can remain in traffic for that period without attention by maintenance staff.

Japan, Nigeria and Republic of Ireland all carry out the examination on a mileage basis apart from certain daily and weekly inspections. In the U. S. A. some of the railways base their examinations on mileage, and others on service hours.

Ceylon. — Examination based on engine hours for power units and mileage for the running gear.

East Africa. — Examinations are carried out on a periodical basis.

New Zealand. — Main-line locomotives on mileage basis and shunting locomotives on periodical basis.

With regard to mileage examinations; it is considered preferable to relate the examination to the type of engine, e.g. a high speed engine may require the mileage examination carried out at a lower mileage than that for a slow running engine, but as more experience is gained the actual mileage for the examinations may be altered as the maintenance of the engine may have to be related to the engine characteristics as determined by oil analysis and oil consumption figures, particularly when approaching high mileage between shopping. The mileage on British Railways may possibly reach 90 000 to 100 000 miles between the shopping periods.

The U. S. A. have no preference for either examinations to be carried out on a mileage or periodical basis but consider that spectographic examination and analysis of oil would be useful as a guide to indicating the condition of the engine.

The New Zealand Government Railways have had to place their Diesel shunters on a periodical basis owing to the fact that reliable mileage data is not readily available for this type of locomotive.

Question 40. — *What is the type and frequency of inspections and periodic overhauls that you have adopted?*

40. — The type and frequency of examination and periodical overhaul varies on the different Administrations. In the U. S. A. the Government requires inspection of locomotives at monthly, 3 monthly, 6 monthly, annual and 5 year periods. Norway examine their locomotives on a periodical basis. British Railways, New Zealand Government Railways, Nigerian Railways and the Republic of Ireland examine their units on a mileage basis, and examples of examinations carried out on a mileage basis for British Railways and New Zealand Government Railways are shown on schedules « A » and « B » and schedule « C » for Republic of Ireland attached.

Question 42. — *Do you consider it advisable to re-profile wheel tyres while the axles remain in place on the locomotive?*

If so, what machinery do you use (or do you suggest should be used)?

42. — There is a difference of opinion in regard to this question. The following Administrations consider it advisable to re-profile wheel tyres whilst the axles remain in place on the locomotive :

British Railways, Ceylon Government Railways, Japan, U. S. A. and Republic of Ireland.

It is not contemplated by East African Railways, Nigerian Railways or Norway. New Zealand Government Railways have had no experience in this matter but state that it is a practice which has obvious attractions and will have to be considered in the future.

The machinery suggested to be used on British Railways is the « Tyre Profile Truing Machine » of the Equipment Manufacturing Co., Chicago, together with Atlas Engineering Co., London.

In America wheel truing machines are commercially available.

Question 43. — *From the point of view of ensuring that operating costs should be as low as possible, do you consider it advisable to carry out maintenance operations so as to extend to the maximum the periods between attention to each of the various parts?*

What number of man hours is given per 1 000 km to the various types of work on each of the principal types of locomotive?

43. — To keep operating costs as low as possible, it is advisable to carry out all examinations before material becomes fatigued. On British Railways Diesel shunting locomotives a typical figure for periodical overhauls and running maintenance is 74 man hours per 1 000 km. Maintenance schedules are carefully watched and where it is possible to extend the period of examination without an adverse effect on the locomotive equipment, this is done, but only where sufficient running experience with the particular type of unit concerned has been gained. Figures are not available for the number of man hours per 1 000 km run on the various types, etc. With regard to the last part of question 43, man hour data is not available for any of the Administrations.

Question 45. — *For engine cooling, do you use :*

— *plain water or water that has been treated, i.e. anti-freeze?*

— *pure distilled water?*

— *water to which a chemical has been added with the object of avoiding corrosion to the jackets and to the Diesel units?*

45. — Whether treated or plain untreated water is used as a coolant is dependent on the conditions in the countries concerned or even in certain districts of one country. It is the usual practice on British Railways for water which is normally in use for the steam locomotives to be used for Diesel engines. Japan, East Africa and Norway use plain water without an additive. In New Zealand a chromate inhibitor is added plus anti-freeze in localities subject to cold winters. Distilled water is used in some engines on the Ceylon Government and Nigerian Railways and on the Nigerian Railways a demineralising plant will be installed for treating mains water in the future. Chemicals are added in an endeavour to avoid corrosion of the water jackets on the following Administrations : New Zealand, Japan and U. S. A.

Question 46. — *What are the average percentages out of service due to :*

— *inspections;*

— *overhauls;*

— *accidental causes.*

46. — Very little data is available as to what the average percentage out of service due to inspection, overhauls or

accidental causes is, and I consider this is principally due to the little experience on some railways with Diesel traction to date. On British Railways the average percentage out of service is equal to 9 %, of which 5 % is due to examinations and 4 % to overhauls. In Ceylon the approximate overhaul is 20 %. The overhaul figure given by East Africa is 29.11 % who have been unable to give breakdown figures.

Question 47. — *Even though it may not be general practice, are there any instances where temporary traffic requirements lead to the replacement of railcars or sets hauled by light railcar units by a heavy set hauled by a Diesel locomotive?*

What stock do you consider should be used in such a case : light rolling stock or vehicles previously used in passenger services?

Alternatively, do you consider it more economic to intensify the service with railcar units?

What provision do you make to have the required number of such units available?

47. — This is not contemplated on British Railways but they consider it would be more economical to intensify the service with rail car units where temporary requirements justify this. In Ceylon, East Africa, and U. S. A. rail cars are not available and trains are worked using existing rolling stock suitable for the particular traffic. In the Republic of Ireland rail cars are replaced by using previously steam heated vehicles hauled by a Diesel locomotive. Any additional requirements of rail cars are covered by the spare units which are available in areas to replace cars under examination, or in shops for repairs.

Question 48. — *If the use of locomotives is never anticipated for passenger services, what is to be done with the heavy rolling stock previously steam hauled?*

Finally, what appears to you to be the most economic solution to this problem if the system is dieselised?

48. — In America the old equipment is scrapped if unable to utilise it at other locations. If the potential traffic warrants, purchase light weight equipment. In East Africa the new stock is of light aluminium construction and will be suitable for attachment to any form of motive power at a future date. On British Railways the heavy rolling stock previously hauled by steam, is, and will be in increasing numbers, hauled by Diesel or electric locomotives. Where multiple unit trains (rail cars) replace steam hauled stock and this stock is not life-expired, it will be absorbed in other services which may be steam, Diesel or electric locomotive hauled. In Ceylon the existing steam hauled rolling stock will continue to be used with the introduction of Diesel locomotives.

Question 49. — *In the instance cited under question 32, where there is a district using a certain number of these locomotives, do you consider it would be useful to organise road motor emergency breakdown service suitably equipped and manned by qualified technical staff?*

Do you think that economies would result in this way by avoiding journeys between station and repair workshop and the consequent immobilisation?

49. — It is considered it would be useful to organise road motor emergency breakdown service suitably equipped and manned by the qualified maintenance staff. In the U. S. A. and in the instances of multiple unit Diesel trains and Diesel shunting locomotives on British Railways, it is considered that economies would result by providing this road service, thus avoiding light running of the loco-

motives or multiple unit trains between out-stations and the repair depot and unnecessary occupation of the line. New Zealand do not consider it necessary on their railways as they have an arrangement whereby minor repairs are undertaken by local motor firms. No definite policy has been entered into as yet by the remaining Administrations concerned.

INSTALLATIONS.

Question 50. — *From the aspect of the general arrangements of installations, how do you organise stores, including fuel — lubricating oil — water — sand; also, inspection and repair of Diesel locomotives?*

50. — Stores. — Stocks of spare parts, lubricating oil, sand, etc. are under the supervision of the Stores Department and it is their duty to keep adequate stocks in hand to meet the requirements on demand from the various Motive Power Depots. The maintenance of adequate water supply is usually under the Engineering Department, and inspection and repair of the Diesel locomotive whilst in service is under the jurisdiction of the Motive Power Department. Each Administration arranges for fuel oil storage facilities at strategic points and the amount held depends on the requirements and locality of the Motive Power Depot concerned.

Question 51. — *What arrangements have you adopted in your installations for storing and distributing large quantities of Diesel oil, size of stores in relation to daily consumption, handling methods, purification process, system of distribution?*

In the instance cited under question 32, how do you organise supply, stocks and distribution of fuel?

51. — The storage capacity for large quantities of Diesel oil varies with the number of locomotives maintained in service at any particular Depot and may be several days' supply or as much as six months' requirements on the Norwegian Railways.

No large installations have yet been built on British Railways, New Zealand Government Railways and East African Railways, but the size required in relation to daily consumption, plus purification of the oil would be taken into consideration when these intallations are built. The oil will be delivered with the aid of either compressed air or electric motor driven mechanical pump, and the piping system will contain suitable filters to filter the oil between the rail car tanks and the storage tanks and again between the storage tank and the locomotive to be serviced.

Underground storage tanks are favoured by Japan and East Africa.

Question 52. — *Do you consider it necessary to provide cover for Diesel locomotives and to heat sheds provided for their protection? What method do you use? Has it proved satisfactory? What alterations have you in mind?*

52. — It is considered necessary to provide cover for Diesel locomotives on the following Administrations : British Railways, New Zealand Government Railways, Ceylon Government Railways, U. S. A., East African Railways, Nigerian Railways and Norway. It it not considered necessary by Japan or Republic of Ireland. It is not necessary for heating to be provided on British Railways, New Zealand Government Railways or the Republic of Ireland nor any tropical or sub-tropical countries, but cover in East Africa etc. is required as protection against torrential rain or dust in dry weather. Where necessary, heating for the comfort of the staff under moderate climatic conditions should be provided and in other countries where colder weather is experienced, e. g. U. S. A. and Norway, both for the protection of the unit and comfort of the staff.

Question 53. — *Do you have, or do you intend having, any special installations for the maintenance of Diesel locomotives, or do you consider that the installations made available by the withdrawal of steam traction will suffice?*

53. — The installations used for the maintenance of steam power are not entirely satisfactory for Diesels. Some of the depots are adaptable to maintenance of both steam and Diesel locomotives by dividing the depot. On a number of railways, however, including British Railways, special Diesel maintenance and repair sheds will be, or are being, built, and on others very considerable re-construction of existing depots will be necessary to meet the requirements of stabling and maintenance of Diesel units.

Question 54. — *What arrangements do you think should be introduced into workshops and sheds for the dispersal of exhaust gas?*

54. — All that is considered necessary for the dispersal of exhaust gas is a duct from the roof to the engine's exhaust and/or the provision of extractor fans. In East Africa and Nigeria the natural ventilation of their depots is such that they do not consider any special arrangements are necessary.

ECONOMY INVESTIGATION.

Question 55. — *What are the reasons which lead you to substitute Diesel traction for steam traction?*

Amongst these reasons, which are those of essentially economic consideration?

55. — There are various reasons which have led to the Administrations preparing to substitute Diesel traction for steam traction. On British Railways there would be a greater availability, and coupled with this, the increasing cost of coal and diminution of suitable supplies must be considered and the expected increased availability should produce economy. In New Zealand the North Island Main Trunk line is reaching traffic saturation, and, pending electrification, the capacity of the line requires enlarging as quickly as possible, and it has been decided as an interim measure to operate the section with Diesel electric locomotives. The main factors in Ceylon are fuel economy, and a higher percentage of availability has achieved the economy expected. In Japan the fuel cost is half that for steam traction. In U. S. A. the characteristics of Diesel traction permit more efficient operation and the elimination of assisting locomotives on many gradients which were necessary when steam locomotives were used. The change-over has achieved all the economy expected. In East Africa the main reason for the change-over to Diesel locomotives is their operating availability and their overall suitability for shunting. In Nigeria the principal reason for the substitution of Diesel traction was the difficulty in obtaining sufficient water for steam locomotives during the dry season in Northern Nigeria. In Republic of Ireland the reason is financial, due to increased costs of coal and the age of steam locomotives.

Question 57. — *Have you effected any economies that you did not foresee? Has the introduction of Diesel traction given rise to extra expenses? What are they?*

57. — No economies have been effected that were not foreseen. Extra expense has been incurred in the building of suitable sheds for Diesel locomotives and oil fuel installations. It is not possible, however, to give any figures in this direction.

Question 58. — *Has dieselisation, by enabling you to offer better services, increased receipts because of improvements in the quality of the service? Can*

you give a percentage indication of this increase in receipts?

58. — British Railways. — At places where steam services have been replaced by Diesel multiple unit trains (rail cars) the receipts have shown increases up to 66 %.

New Zealand. — The substitution of rail cars for steam passenger services during the next two years is expected to increase receipts considerably.

Ceylon. — To a certain extent; the figures are not available.

U. S. A. — Better services are provided because of maintaining higher average speeds and the elimination of service stops for steam locomotives. It is also considered the drawbar characteristics of the Diesel locomotives are superior to the steam locomotive.

Republic of Ireland. — There is a better service but no statistics are yet available.

The remaining countries are not in a position to comment in detail.

Question 59. — *Does it appear to you that the substitution of Diesel for steam traction is likely to result in a considerable decrease in the risk of fires alongside the track? If so, can you give any statistics to indicate this advantage?*

59. — It is considered that by the utilisation of Diesel locomotives there will be a reduction in lineside fires but no statistics are available from the Administrations.

Question 60. — *Does it appear to you that the substitution of Diesel for steam traction is likely to lead to economy in track maintenance?*

What is your percentage estimate to this saving?

60. — British Railways. — Unable to state whether there will be any economy in track maintenance as we have insufficient experience at the moment.

New Zealand, Ceylon and Japan state that it appears a marked economy can be ensured in track maintenance by the substitution of diesels, but no statistics are available.

U. S. .A. consider that there is a saving in track maintenance especially on curves, but no estimate of the savings is available.

Question 63. — *In the substitution of Diesel for steam traction, what is your percentage estimate of resultant economies :*

— for train haulage service?

— for shunting service?

and for each of the following :

— fuel (calculation to be made with and without special motor fuel taxes payable by the railways);

— locomotive crews;

— maintenance and repair of rolling stock (labour and material separately)?

Note. — In order to show the comparison please take as a basis for both forms of traction :

— train haulage, the same number of gross tonnes-km hauled;

— shunting, the same number of wagons shunted.

63. — The substitution of Diesel for steam traction and the estimate of resultant economy is a question which has been gone into by all the Administrations concerned but no exact figures are available, and, in the majority of the Administrations there is insufficient data available for exact figures to be drawn up. The U. S. A. quote savings ranging from 20 % to 40 % and Norway a saving of — train hauling service, 30 %, — shunting service, 25 %, locomotive crews, — 40 % and maintenance, — 50 %. New Zealand have produced a statement, which is shown below.

For main-line locomotives of roughly comparable power costs based on current fuel and other prices, equipment capital costs, and relative annual mileages were recently taken out.

New Zealand.	*Costs per Engine Mile* (pence)	*Ratio of relative costs*
Single unit 1 500 HP Diesel electric . . .	79.9	100
Steam locomotive burning native sub-bituminous coal	104.9	131.2
Steam locomotive burning fuel oil . . .	116.1	144.2
Steam locomotive burning native bituminous coal	128.9	161.5

No statistical data available.

Estimated saving on using Diesel mechanical instead of steam in 1950 was £20 per day. Relative first costs, interest and depreciation were not taken into account.

	Pence per Mile	*Ratio of relative costs*
1 500 HP single unit Diesel electric . . .	17.5	100
Steam locomotive burning sub-bituminous coal	40.7	233
Steam locomotive burning fuel oil . . .	51.5	294
Steam locomotive burning bituminous coal	64.7	370

Economies in the use of engine crews are more difficult to estimate. As double manning of Diesel electrics on main-lines is the rule on this railway such savings as are made derive not from the ability to operate this power with only one man but through the reduction of depot servicing man hours due to the ability of Diesels to make long runs without subterminal engine changes. The consequential staff economy is assessed at about 20 %. Diesels work in pairs in multiple over difficult mountain areas with only one man; saving on these sections 50 % manpower.

Economies in maintenance and repair cannot be stated as no diesels have yet required overhauls.

CONCLUSION.

In the statement containing the main replies to the questionnaire which was circulated to the various English-speaking Administrations, it was realised that a comprehensive reply to all the questions would mean that a very unwieldy statement would have to be produced, and, accordingly your Reporter has considerably condensed the replies in most cases and in so doing has endeavoured to maintain their value. He wishes to express his thanks to those Administrations who have supplied the information requested.

To keep the conclusion within reasonable limits, comment has only been made on a few of the subjects which are considered of paramount importance.

It was generally not considered that a single type of locomotive could satisfactorily cope with the requirements of an Administration. For main-line working single unit locomotives of 1 000-3 600 HP appear to be most suitable, working in multiple if required, and for secondary services locomotives of 750-1 700 HP are considered desirable. Shunting services are covered by locomotives of 350-600 HP and are largely used for general purposes, apart from small units of 200 HP or less which may be used for shunting at small stations and depots. Locomotives over

600 HP are required on some Administrations where the weight of the trains merit this, e. g. on the Railways in the U. S. A.

The problem of train heating appears to be the most difficult requiring solution, and on railways where large numbers of vehicles are already fitted for steam heating and do not merit conversion, the only method which can be adopted is for steam heating boilers to be fitted on the locomotive concerned, or a steam heating boiler be carried in a special vehicle which could be attached to the train as required. This latter system has disadvantages as it reduces the number of passenger carrying vehicles that may be hauled on a train of a given loading. Difficulties could arise, where, at a junction the train is divided to be worked forward in two parts, as it may not be possible to have a second steam heating van available to cover the second portion. In addition, difficulty could be experienced with the disposal of the heating vehicle at terminal stations.

On Administrations where electrification is considered, it may be possible in the future for the steam heating apparatus fitted on Diesel locomotives to be replaced by Diesel driven generator equipment for heating trains equipped with electrical radiators.

The axle arrangements on some of the Administrations vary very considerably, and this may be caused by the general characteristic of the track and tractive effort required on the various railways. For train haulage the Co-Co type appears to be mostly in favour, but up to the present there is no data available as to what axle arrangement ensures maximum economy in track maintenance.

There is a considerable difference of opinion as to the relative merits of the 2-stroke or 4-stroke engine and the position appears to be that before any useful comment can be expressed on the use of 2-stroke Diesel engines for rail traction, further experience, mostly of an experimental nature, would be required with the latter type of engine before a definite opinion could be given.

BRITISH RAILWAYS, SCHEDULE "A"

STANDARD EXAMINATIONS OF DIESEL-ELECTRIC MAIN LINE LOCOMOTIVES

Electrical items are indicated by the letter "E", i.e. Item No. 42E.

Item No.	*Daily Examination.*
1.	Clean by-pass lubricating oil filters and inspect for white metal.
2.	Check pressure charger oil levels and fill if necessary.
3.	Check engine sump lubricating oil level and fill if necessary.
4.	Fill fuel tank.
5.	Fill radiator header tank if necessary.
6.	Fill boiler water tanks.
7.	Change over fuel filters.
8.	See that lubricating oil pressure is normal and give one turn to Auto-klean filters.
9.	See that engine speed control is functioning correctly.
10.	Check operation of sanding gear and that sandboxes are full.
11.	Drain water from all air reservoirs.
12.	Check water pumps for leaks.
13.	Inspect generally for water, lubricating oil, fuel oil and air leakage.
14.	Inspect cylinder heads for water leakage.
15.	Check operation of deadman's device and brakes.
16.	Check operation of engine manual shut down.
17.	See that detonator case is in position and that seal is intact.
18.	Test in steam, C.W. apparatus during C.W. season.
19.	General examination.
20.	Fill trimming oil boxes — insert trimmings prior to locomotive moving off.
	On completion of examination, the Diesel engine is to be cleaned down and surplus oil cleared from engine drain trays and floor of engine room. Sealing plate to be drained.

Item No.	*5-6 000 Miles Examination.*
24.	Check exhauster sump, oil levels, and fill if necessary.
25.	Check operation of radiator shutters for ease, and lubricate if necessary.
26.	Clean Auto-klean strainers on engine (where fitted).
27.	Clean exhauster snifters.
28.	Clean engine air intake filters.
29.	Check that all drain pipes are clear.
30.	Grease bolster rubbing plates.
32.	Oil bolster pads through oil boxes in boiler and engine compartments and thrust and segment boxes.
33.	Lubricate external linkage to governor and connections.
34.	Examine wheels and tyres.
35.	Check brake gear.
36.	Test air refuelling heads.
37.	Check engine overspeed device.
38.	Check lubricating oil level in suspension bearing oil boxes and fill up if necessary.
39.	Check oil levels in gear cases and fill up if necessary.
40E.	Check all lighting.
41E.	Check all spare fuses are in position and loaded.
42E.	Check bogie cabling to traction motor.
43E.	Check jumper couplings for tightness (when in multiple unit).
44E.	Inspect lubricating oil control switches.
45 E.	Examine brush holders and commutators and clean insulators and Vee rings of blower motors.
46 E.	Vacuum clean cubicle and floor of compartment.

Item No.	*20-24 000 Miles Examination.*
50.	Drain water and sludge from fuel tanks.
51.	Drain sludge from radiator header tank.
52.	Clean compressor air intake filters.
53.	Clean Vokes lubricating oil filters in petrol. (Do not use air jet).
54.	Clean Vokes fuel filters with petrol. (Do not use air jet).
55.	Check level of lubricating oil in lubricating oil pump gear box and fill up if necessary.

Item No.	
56.	Check lubricating oil levels in compressors and top up if necessary.
57.	Drawgear to be carefully examined in position.
58.	Examine and clean generator compartment filters.
59.	By operating lubricating oil hand priming pump check that rocker fulcrum pins and push rod eyes are receiving lubrication.
60.	Check that cam shaft drives and jockey pulley are receiving lubrication.
61.	Check cam shaft chain for tension.
62.	Inspect cam shaft and see that cam followers are in good condition.
63.	Check valve tappet clearances and check for slackness at rocker fulcrum pins.
64.	Check valve springs for fractures etc.
65.	Fit spare set of injectors and recondition as soon as possible the injectors taken out.
66.	Conduct vacuum brake efficiency test.
67.	Check exhaust manifolds for leaks.
68.	Check air intake manifolds for leaks.
69.	Send sample of lubricating oil to Chemical Lab. Sample to be labelled and dated.
70E.	Examine, top up, check connections and log specific gravity of four pilot battery cells (main battery).
71E.	Remove, clean, top up, charge and clean container and replace emergency service six volt accumulator.
72E.	Examine brushes and holders, commutators and clean insulators and Vee rings on all machines.
73E.	Inspect starting contactor tips.
74E.	Check fire alarms and warning devices.
75.	Clean radiator elements externally using compressed air.

Item No.	*60-72 000 Miles Examination.*
78.	Check oil level in axleboxes. Top up only if level reaches bottom mark on gauge. Drain off lubricant if dirt or oil are suspected and flush with light oil.
79.	Operate lubricating oil hand priming pump and check that main, big end, small end and cam shaft bearings are receiving lubrication.
80.	Check main and big end bolts for security.
81.	Examine crankcase bolts.
82.	Check coupling between engine and generator.
83.	Inspect bellows between blower ducts and traction motors.
84.	Drain pressure chargers and inspect sludge for bearing flakes.
85E.	Look in control cubicle for obvious defects.
86E.	Check operation and condition of E.P. reverser and contactors.
87E.	Check operation and condition of relays.
88E.	Check resistances for burns and loose connections.
89E.	Check load regulator operation and condition.
90E.	Check controller operations and condition.

SCHEDULE "A"

STANDARD EXAMINATIONS FOR DIESEL ELECTRIC SHUNTING LOCOMOTIVES.

Mechanical Examinations.

10-15 Days Examination.

1.	Remove and clean lubricating oil filters (2). If metal is found in filters, or oil pressure abnormally low, main and big end bearings to be examined.
2 & 2A.	Adjust brake if necessary, check proportional application of air brake by the operation of the vacuum brake where fitted.
4.	Fill fuel tanks.
5 & 5A.	Lubricate R.P.M. counter and mileometer including mechanical drive gearboxes where fitted.
6.	Jackshaft oil pump filter to be cleaned if necessary.

7. Jackshaft and engine axlebox underkeeps to be filled if necessary.
8. Make up oil levels in mechanically driven air compressors, Diesel engine sump and traction motor gear case if necessary.
9. General examination for loose parts.
10. Drain sediments from fuel oil filter (Auto-Klean).
11. (Except at 10 000-12 000 miles — see Item 45). — A sample of oil shall be taken from the engine sump, and tests for dilution — by rolling sphere viscometer — and for dirt content by comparison with the standard chart must be carried out.

    If dilution is above 5 %, send sample of oil to the Chemical Laboratory, labelled as shown in the instructions, headed "Oil Sampling".

    If the dirt content is greater than 0.1 % the Fram Filter Cartridges must be changed at the earliest opportunity.
12. Lubricate fan shaft bearings as required.
13. Fill Kingfisher lubricators to valve stems, where fitted, with a 50-50 mixture of motor lorry oil and paraffin.
14. With the Diesel engines running, start the vacuum exhausters by closing the exhauster switch in the driver's cab and allow them to run at normal speeds for a period of 15 minutes.

    Check immediately on starting that the lubricating oil pump is working. If not, stop the exhausters and prime pump before restarting.

800-1 000 Miles Examination.

15. Examine and clean all air filters including air compressor.
16. All grease cups to be filled and nipples on brake gear, brake cylinder and blower to be lubricated.
17. Mileometer and jackshaft pump worm drive to be lubricated.
18. Examine : Fan, blower and exciter belts, also compressor belts where fitted, adjust if necessary.
19. Examine inlet and exhaust valve springs.
20. Examine fuel lubricating oil and air pipes for leaks.
21. Examine water pipes and connections, including water pumps for leaks.
24. Examine and clean if necessary, fuel pump chamber and drain pipes, bed plate oil drain pipe and reservoirs, and lubricate fuel pump control shaft and racks.
25. Test air compressor and lubricate standage couplings of exhauster set where fitted.
26. Test deadman's device in position, and carry out vacuum brake efficiency test after running the exhausters for at *least* 15 minutes at normal speed.
27. Check inlet and exhaust valve clearances.
28. Remove crank case doors and examine : (See instructions under heading "Examination of crank case, big end bolts, etc...").
    (a) Big end and main bearing bolts.
    (b) Lubricating oil pipe lines.
    (c) Oil flow from big ends and main bearings, examine cylinder liners for score marks.
    (d) Examine camshaft bearings, cams and rollers, for correct lubrication.
29. Remove and test fuel injectors.
30. Check cylinders for correct firing.
31. Check oil feeds to engine governor and valve rockers — valve rocker feeds to be set at the rate of 5-6 drops per minute, and the governor feed to be a steady stream when the lubricating oil temperature is over 90° F.
32. Clean radiator with air or steam jet if necessary.

5 000-6 000 Miles Examination.

33. Examine wheels and tyres.
34. Examine air system valve (90 lbs. per sq. inch).
35. Drain off water from fuel oil tanks.
36. Remove and clean tank inlet fuel oil filter.
37. Remove and examine engine drawgear.

38. Check crankshaft alignment (see instructions). Copy of readings to be sent to the "Chief Mechanical & Electrical Engineer".

10 000-12 000 Miles Examination.

41. Remove exhaust valve cages and grind in valves (see instructions).
42. Examine for tension, the driving chains to the camshaft, lubricating oil and water pumps.
43. Examine side rods in position, and check oil consumption, if necessary change felt pad.
44. Anneal copper pipes (non-flexible type) when fitted on air compressor.
45. Take sample of oil from engine sump and place in a clean bottle. (See instructions re-labelling etc.), in addition, give locomotive number and mileage, type of oil and date, also mileage since Fram filter cartridges were changed and forward to the Chemical Laboratory, for analysis.

20 000-24 000 Miles Examination.

46. Remove inlet valve *cages* and grind in valves — see instructions regarding cageless type valves.

PROPOSE FOR SHOPS AT 26 000-30 000 MILES.

STANDARD ELECTRICAL EXAMINATIONS OF DIESEL ELECTRIC SHUNTING LOCOMOTIVES.

Electrical Examinations.

10-15 Days Examination.

(a) Check oil levels in motor driven vacuum exhauster sumps and fill if required.

(b) Check electrolyte level in batteries and top up if necessary.

Every 800-1 000 Miles Examination.

1. Inspect operation of controls.
2. Lubricate traction motor armature bearings, and suspension bearings and check oil level in electric motor driven air compressor sumps, fill if required.

Note :— D.H. 16 type air compressor :—

(1) The machine should be shut down at least half-an-hour before the sump level is checked.

(2) When topping up, sufficient oil has been added when it is just visible in the bottom of the filling elbow.

Examine, trim, clean, lubricate and adjust as required :—

3. Controllers including reverser. (Every third mileage examination).
4. Relays. (Every third mileage examination).
5. Pneumatic and oil pressure switches. (Every third mileage examination).
6. Contactors. (Every third mileage examination).
7. Inspect operation of engine's speed change gear and deadman's gear.
8. *Batteries :—*

   Lead Acid — Examine and log the four pilot cells and top up.

   Nife — Test, top up and clean.
9. Examine commutator and brush gear of all machines, and every third mileage examination blow out brushgear of all machines.
10. Clean generator compartment air filters (where fitted), every third mileage examination.

Every 5 000-6 000 Miles Examination.

11. Examine the interiors, also blow out, clean, grease and test brush pressures of the following machines :—

    Main Generator
    Traction Motor
    Auxiliary Generator (where fitted)
    Radiator Fan Motor » »
    Blower Motor » »
    Compressor Motor » »
    Exhauster Motor » »
    Priming Pump Motor » »
    Torque Control Generator (where fitted).

12. *Batteries :—*

Lead Acid — Top up, clean and carry out equalising charge as per instructions.

Nife — Test, top up, clean and log specific gravities of electrolyte.

Shopping periods or overhauls.

Every 26 000-30 000 Miles the locomotive should be proposed for shopping for an *intermediate repair.*

Every 52 000-60 000 Miles the locomotive should be proposed for shopping for a *general repair.*

108 A.H. Lead Acid Battery.

Inspection between mileage examinations. — It will be appreciated that in some instances the period in service between mileage examinations will be too long for trouble free battery performances. All lead acid batteries should therefore be checked for electrolyte level at the 10-15 days examination, and given attention which may be necessary.

Instructions for equalising charge to be carried out at the 5 000-6 000 miles examination.

Commence charge at 15 amperes until pilot cells reach a voltage of 2.35. Complete charge at 7 amperes until specific gravities and voltages are constant for *four* consecutive *hourly* readings.

Voltages and specific gravities should be *taken hourly* on four pilot cells during the charging period and on all cells on completion of charge, before the current is cut off. Any cell whose voltage is lower than the pilot cells by .1 volt or whose specific gravity is lower than the pilot cell by 20 points must form the subject of a special written report.

In addition the temperature of the electrolyte in the four pilot cells should be taken hourly during the charge.

NEW ZEALAND GOVERNMENT RAILWAYS

CARE MUST BE TAKEN TO KEEP THE ENGINE, ENGINE ROOM GENERATOR COMPARTMENT

	Operation nº	PARTS TO BE ATTENDED TO IF FITTED
ENGINE TOP	A - 1	Check pressure charger oil levels
	A - 2	Inspect for gasket blow and water leakage at cylinder heads
	A - 3	Lubricate fuel pump racks and fuel pump plunger guides
	A - 4	Check valve springs for fracture
	A - 5	Lubricate valve stems (kingfisher lubricators).
	A - 6	Check tappet clearances and check for slackness at rocker fulcrum pins
	A - 7	Examine and clean engine air intake filters (monthly in summer and autumn)
	A - 8	By operating lub. oil hand priming pump check that rocker fulcrum pins and push rod eye bolts are receiving lubrication.
	A - 9	Drain pressure charger oil tanks and inspect sludge for bearing flakes.
	A - 10	Remove and clean fuel injectors : dismantle and recondition if blow-off pressure is down by 9 atmospheres or if spray is unsatisfactory
	A - 11	Check rocker fulcrum pins and bushes for wear
	A - 12	Remove pressure charger air intakes and examine for bearing oil leakage
	A - 13	Remove cylinder heads : clean and reseat inlet and exhaust valves
	A - 14	Dismantle pressure chargers for cleaning and renew ball bearings.
	A - 15	Check „facing" of cylinder heads.
	A - 16	Test cylinder heads (10 lbs per sq. in.) for cracks, etc. in casting
ENGINE MIDDLE	B - 1	Pump lub. oil by hand and see that oil pressure switch closes at 10 lbs. per sq. in. and that all fuel racks attain full fuel position. (solenoid lifted).
	B - 2	Check fuel pump rack control gear and examine racks for freedom of movement
	B - 3	Lubricate external linkage to governor and lubricate connections
	B - 4	Checks for fuel leakage between pumps and injectors
	B - 5	Inspect cam shaft and see that cam followers are in good condition.
	B - 6	Remove and clean governor oil strainer
	B - 7	Withdraw pistons and check cylinder liners for wear, rings for gaps and connecting rods for twist
	B - 8	Inspect camshaft couplings and bearings.

SCHEDULE ' B '

ALL PARTS FREE FROM OIL, OILY DIRT, OR ANYTHING LIKELY TO CATCH FIRE

Instr. book reference ook nº 18/ /			Daily	2 000 miles	8 000 miles	25 000 miles	50 000 miles	100 000 miles
.	Page nº	Par, or Section						
			A - 1	A - 1	A - 1	A - 1	A - 1	A - 1
			A - 2	A - 2	A - 2	A - 2	A - 2	A - 2
				A - 3	A - 3	A - 3	A - 3	A - 3
				A - 4	A - 4	A - 4	A - 4	A - 4
			A - 5	A - 5	A - 5	A - 5	A - 5	A - 5
					A - 6	A - 6	A - 6	A - 6
					A - 7	A - 7	A - 7	A - 7
					A - 8	A - 8	A - 8	A - 8
						A - 9	A - 9	A - 9
					A - 10	A - 10	A - 10	A - 10
							A - 11	A - 11
								A - 12
								A - 13
								A - 14
								A - 15
								A - 16
				B - 1	B - 1	B - 1	B - 1	B - 1
				B - 2	B - 2	B - 2	B - 2	B - 2
				B - 3	B - 3	B - 3	B - 3	B - 3
				B - 4	B - 4	B - 4	B - 4	B - 4
					B - 5	B - 5	B - 5	B - 5
						B - 6	B - 6	B - 6
								B - 7
								B - 8

	Operation n°	PARTS TO BE ATTENDED TO IF FITTED
ENGINE BOTTOM	C - 1	Check level of engine lubricating oil in sump and fill if necessary to dipstick level
	C - 2	Operate hand lub. oil pump (engine cold), and see that normal pressure can be maintained.
	C - 3	See that lubricating oil pressure is normal
	C - 4	Clean lubricating oil strainers and examine for white metal.
	C - 5	Check viscosity of engine oil and change if necessary
	C - 6	—
	C - 7	Examine crankcase holding down bolts
	C - 8	Check coupling between engine and main generator
	C - 9	Send sample of engine oil to W.S.M. hutt. for test (see C5)
	C - 10	By operating hand lub. oil pump. check that main bearings, big end bearings, small end bearings and cam shaft bushes are receiving lubrication
	C - 11	Check big end and main bearing bolts for security
	C - 12	Check crankshaft alignment with bearing caps in position
	C - 13	Check tension of camshaft driving chain.
	C - 14	Examine the engine driven lub. oil pump and water pump gears
	C - 15	Inspect big end bearings and remove and examine gudgeon pins for wear
	C - 16	Remove crankshaft and check for wear and ovality
	C - 17	Inspect main bearings.
ENGINE RUNNING	D - 1	Listen for unusual noises, check firing of cylinders and engine speed.
	D - 2	Inspect water lub. and fuel oil pipes and cylinder heads for leakage
	D - 3	Check operation of manual engine controls
	D - 6	Check speed control is functioning correctly by operating controller.
	D - 8	Check operation of emergency governor.
	D - 10	Check accuracy of engine tachometer

Instr. book reference ok nº 18/ /		Daily	2 000 miles	8 000 miles	25 000 miles	50 000 miles	100 000 miles
Page nº	Par, or Section						
		C - 1	C - 1	C - 1	C - 1	C - 1	C - 1
			C - 2	C - 2	C - 2	C - 2	C - 2
		C - 3	C - 3	C - 3	C - 3	C - 3	C - 3
			C - 4	C - 4	C - 4	C - 4	C - 4
			C - 5	C - 5	C - 5	C - 5	C - 5
					C - 7	C - 7	C - 7
					C - 8	C - 8	C - 8
			C - 9	C - 9	C - 9	C - 9	C - 9
					C - 10	C - 10	C - 10
					C - 11	C - 11	C - 11
						C - 12	C - 12
				C - 13	C - 13	C - 13	C - 13
							C - 14
							C - 15
							C - 16
							C - 17
		D - 1	D - 1	D - 1	D - 1	D - 1	D - 1
		D - 2	D - 2	D - 2	D - 2	D - 2	D - 2
		D - 3	D - 3	D - 3	D - 3	D - 3	D - 3
		D - 6	D - 6	D - 6	D - 6	D - 6	D - 6
			D - 8	D - 8	D - 8	D - 8	D - 8
				D - 10	D - 10	D - 10	D - 10

	Operation n°	PARTS TO BE ATTENDED TO IF FITTED
MISC.	O - 1	Check that all drain pipes are clear
	O - 4	Check exhaust, water and lub. oil temperature gauges against standard thermometers
	O - 5	Examine and check all water and oil pumps
	O - 6	On re-assembly, subject engine to full test procedure
	O - 7	Dismantle and clean all valves in the lub. oil system.
	O - 8	Clean all oil filters and strainers
AUXILIARIES	P - 1	Check that fuel tanks and radiator are full
	P - 2	Drain air reservoir
	P - 3	Check lubricating oil level in compressors
	P - 8	Clean fuel strainers and filters
	P - 10	Drain water and sludge from fuel tank
	P - 11	Clean compressor intake filters
	P - 12	Clean power compartment filters
	P - 15	Inspect air bellows between blower ducts and traction motors
	P - 16	Drain, steam out and clean all fuel tanks
	P - 17	Check operation of warning devices.
	Q - 2	Check that sand boxes are full
	Q - 3	Check operation of sanding equipment
	Q - 4	Generally examine the bogies and grease.
	Q - 8	Examine wheels and types
	Q - 10	Examine draw gear pins and rubbing plates, etc.
		M.I. 371/6/8/1.
		Loco. Nos. 501 to 515

Instr. book reference book nº 18/ /			Daily	2 000 miles	8 000 miles	25 000 miles	50 000 miles	100 000 miles
.	Page nº	Par. or Section						
				O - 1	O - 1	O - 1	O - 1	O - 1
								O - 4
								O - 5
								O - 6
								O - 7
								O - 8
			P - 1	P - 1	P - 1	P - 1	P - 1	P - 1
			P - 2	P - 2	P - 2	P - 2	P - 2	P - 2
			P - 3	P - 3	P - 3	P - 3	P - 3	P - 3
			P - 8	P - 8	P - 8	P - 8	P - 8	P - 8
				P - 10	P - 10	P - 10	P - 10	P - 10
					P - 11	P - 11	P - 11	P - 11
					P - 12	P - 12	P - 12	P - 12
						P - 15	P - 15	P - 15
								P - 16
							P - 17	P - 17
			Q - 2	Q - 2	Q - 2	Q - 2	Q - 2	Q - 2
				Q - 3	Q - 3	Q - 3	Q - 3	Q - 3
				Q - 4	Q - 4	Q - 4	Q - 4	Q - 4
				Q - 8	Q - 8	Q - 8	Q - 8	Q - 8
							Q - 10	Q - 10

ocos class D.E. (660 HP) - maintenance chart - for mechanical equipment

NEW ZEALAND GOVERNMENT RAILWAYS

CARE MUST BE TAKEN TO KEEP THE ENGINE, ENGINE ROOM GENERATOR COMPARTMENT

	Operation nº	PARTS TO BE ATTENDED TO IF FITTED
CONTROL	F - 1	See that spare fuses are on the loco. . . . .
	E - 2	Check all lamps-internal and external . . . . .
	E - 3	Check operation of "deadman's" device. . . . .
	E - 4	Check charging rate after starting. . . . .
	E - 5	Check windscreen wipers and cab heaters . . . . .
	E - 6	—
	E - 7	—
	E - 8	—
	E - 9	Look in electrical cabinet for obvious defects. . . . .
	E - 10	—
	E - 11	—
	E - 12	—
	E - 13	Check operation of reverser . . . . .
	E - 14	Check operation of master controller and observe contact fingers. . . . .
	E - 15	Check operation and condition of relays. . . . .
	E - 16	Check operation and condition of contactors and interlocks . . . . .
	E - 17	Check resistors - no loose contacts or burns . . . . .
	E - 18	Check operation of motor operated regulator . . . . .
	E - 19	—
	E - 20	Check that all connections are tight 4 weeks after new loco. in service or after overhaul
	E - 21	—
	E - 22	—
	E - 23	—
	E - 24	—
	E - 25	—
	E - 26	—
	E - 27	
	E - 28	—

ALL PARTS FREE FROM OIL, OILY DIRT, OR ANYTHING LIKELY TO CATCH FIRE

Instr. book reference ok n° 18/ /		1 000 miles	2 000 miles	8 000 miles	25 000 miles	50 000 miles	100 000 miles
Page n°	Para or Section						
			E - 1	E - 1	E - 1	E - 1	E - 1
			E - 2	E - 2	E - 2	E - 2	E - 2
			E - 3	E - 3	E - 3	E - 3	E - 3
			E - 4	E - 4	E - 4	E - 4	E - 4
			E - 5	E - 5	E - 5	E - 5	E - 5
					E - 9	E - 9	E - 9
					E - 13	E - 13	E - 13
						E - 14	E - 14
					E - 15	E - 15	E - 15
					E - 16	E - 16	E - 16
					E - 17	E - 17	E - 17
					E - 18	E - 18	E - 18
							E - 20

	Operation n°	PARTS TO BE ATTENDED TO IF FITTED
MOTORS AND GENERATORS		TRACTION MOTORS
	F - 1	Check oil level of traction motor suspension bearings
	F - 2	See that traction gears have sufficient lubricant and that covers are tight
	F - 3	Check brushes and holders
	F - 4	Examine commutators and clean „V" rings
	F - 5	Clean brush insulators
	F - 6	Grease armature bearings each bearing one ounce
	F - 7	Overhaul traction motor completely
		MAIN GENERATOR
	G - 1	Examine brushes and holders-clean insulators
	G - 2	Examine commutators and clean „V" ring
	G - 3	—
	G - 4	Grease armature bearing each bearing one ounce
	G - 5	Grease trunnion bearings
	G - 6	—
	G - 7	Overhaul generator completely
		AUXILIARY GENERATOR
	J - 1	Examine brushes and holders-clean insulators
	J - 2	Examine commutator and clean „V" ring
	J - 3	—
	J - 4	—
	J - 5	Overhaul auxiliary generator completely

Instr. book reference ok nº 18/ /			1 000 miles	2 000 miles	8 000 miles	25 000 miles	50 000 miles	100 000 miles
.	Page nº	Para or Section						
			F - 1	F - 1	F - 1	F - 1	F - 1	F - 1
				F - 2	F - 2	F - 2	F - 2	F - 2
				F - 3	F - 3	F - 3	F - 3	F - 3
					F - 4	F - 4	F - 4	F - 4
						F - 5	F - 5	F - 5
							Every six months	
								F - 7
				G - 1	G - 1	G - 1	G - 1	G - 1
				G - 2	G - 2	G - 2	G - 2	G - 2
						Every six months		
						Every six months		
								G - 7
				J - 1	J - 1	J - 1	J - 1	J - 1
				J - 2	J - 2	J - 2	J - 2	J - 2
								J - 5

	Operation nº	PARTS TO BE ATTENDED TO IF FITTED
MOTORS AND GENERATORS		BLOWER MOTORS
	L - 1	Examine brushes and holders-clean insulators . . . . .
	L - 2	Examine commutators and clean „V" rings . . . . .
	L - 3	—
	L - 4	Grease armature bearings each bearing half ounce . . . . .
	L - 5	—
	L - 6	Overhaul blower motors completely. . . . .
		FAN MOTOR
	M - 1	Examine brushes and holders-clean insulators . . . . .
	M - 2	Examine commutator and clean „V" ring . . . . .
	M - 3	—
	M - 4	Grease armature bearings each bearing half ounce . . . . .
	M - 5	—
	M - 6	Overhaul fan motor completely. . . . .
		REGULATOR AND PRIMING PUMP MOTORS
	N - 1	Examine brushes and holders-clean insulators . . . . .
	N - 2	Examine commutators . . . . .
	N - 3	—
	N - 4	Grease armature bearings . . . . .
	N - 5	—
	N - 6	Overhaul motors completely . . . . .
		BATTERIES
	H - 1	Examine and top up battery, log sp. gr. of pilot cells (2 on each side of loco). . . . .
	H - 2	Examine, clean all cells and give battery an equalising charge. . . . .
		M.I. 371/6/7/2.
		Locos Nos. 501 to 515

Instr. book reference ok nº 18/ /			1 000 miles	2 000 miles	8 000 miles	25 000 miles	50 000 miles	100 000 miles
	Page nº	Para or Section						
				L - 1	L - 1	L - 1	L - 1	L - 1
				L - 2	L - 2	L - 2	L - 2	L - 2
					Every six months			
								L - 6
					M - 1	M - 1	M - 1	M - 1
					M - 2	M - 2	M - 2	M - 2
					Every six months			
								M - 6
							N - 1	N - 1
						N - 2	N - 2	N - 2
							Every 12 months	
								N - 6
				H - 1	H - 1	H - 1	H - 1	H - 1
							H - 2	H - 2

s class D.E. (660 HP) - maintenance chart - for electrical equipment

SCHEDULE "C"

EXAMINATION SCHEDULE C.I.E. — REPUBLIC OF IRELAND

Questions 40 and 41 — Inspection and Periodic Overhaul.

Daily or 300 miles.

(N.B. — Some of these checks appear also in the "Driving Instructions" to which reference should be made for the procedure for starting the engine, checking the brake equipment, etc.).

Engine.

Check fuel, water and lubricating oil supplies.
Check for leakages.
Check as far as possible that the following are satisfactory :—
Exhaust colour.
Water and lubricating oil temperatures.
Lubricating oil pressure.
Sight feed lubricators.
Scavenge air pressure.
Rotate handle of Autoklean strainer 3 or 4 times.
Check that all cylinders are cut in (lever short arms up).
Check that overspeed governor is latched in.

Control Equipment.

Test lights.
Check that covers are on all electrical equipment.
Check that motor cut-out switch is at "ALL IN" position.
Check that earth fault relay isolating switch is at "IN" position.

Brake and Air Equipment.

Check the handbrake.
Check the vacuum brake.
Check that isolating and towing valve is in "RUN" position with seal unbroken.
Check that air system cock handles are in the correct positions.
Check the horns.
Check the sanders and sand supply.

Mechanical Parts.

Check interior is tidy.
Inspect running gear.
Check that there are no leakages of fuel, lubricating oil or water and that drain cocks are securely closed.
Check that louvre doors over engine air filters are secured.
Check window wipers.
Check all fire extinguishers are on locomotive.

Weekly or 2 000 miles.

Daily service plus :

Engine.

Water pumps — Screw down greasers half a turn.
Fuel suction filter — Remove element and clean.
Fuel suction non-return valve — Remove and clean Autoklean filter — Drain any sludge from body silencer — Check that drain is clear.

Control Equipment.

Battery — Add distilled water as necessary to the cells and read S.G. of pilot cell.

Brake and Air Equipment.

Examine all hose connections, couplings and miniature sacks.
Check oil level in exhauster and compressor sump.
Blow out dirt collectors and reservoir drain cocks.

Mechanical Parts.

Apply grease to all nipples on bogies (supplying brake suspension pins and upper ends of bolster swing links).
Drain any water or sludge from bottom of fuel tank.
Check all tools and spares are on locomotive.

Monthly or 8 000 miles.

Weekly service plus :

Engine.

Fuel sprayers — Remove from engine and check.
Fuel pump — Test each pump line for solidity.
Cylinder head gaskets — Inspect for signs of blowing. Nuts to be checked for torque.
Safety valves in heads — If signs of blowing, remove and clean. Oil before replacing.
Lubricating oil strainers in base — Remove and thoroughly clean.
Duplex fuel filter — Remove element and clean.
Autoklean filter — Remove element. Clean element and filter body.

Lubricating oil — Take sample for chemist analysis.
Water — Take sample for chemist analysis.

Control Equipment.

E.P. Motor switches and reverser — Check operation, examine contacts and tighten contact screws.
Starting contactors — Check operation, examine contacts.
All magnet valves — Test for air leakage.
All interlocks (inc. contacts in brake valve) — Examine.
Engine speed regulator — Check operation and lubricate cylinders.
Load regulator — Check operation of control valves and examine contents.
Battery relay — Check freedom of movement, clean contacts if necessary.
T.M. Field weakening resistance — Check for loose connections.
Voltage regulator — Check contact gap and voltage setting.
Battery — Clean cell tops if necessary, check tightness of terminals and vaseline if necessary.

Electrical Machines.

Examine commutators of all machines, clean and inspect brushgear, insulators, Vee rings and insulation over the risers.
Top up T.M. axle bearings and gearcases.

Brake and Air Equipment.

Dismantle, clean and test snifters.
Check vacuum system for leakage.
Check train pipe clear. (Take each end hose off in turn and check T.P. vacuum will not rise about 3" Hg. with exhauster at high speed).
Check brake cylinder piston travel. Adjust or renew blocks as necessary.
Check compressor governor for correctness of setting and clean strainer.
Check safety valve blow-off setting.
Clean strainer of control reducing valve and check setting.
Clean strainers for control and horns.
Clean filter element of exhauster air strainer.
Check exhauster lubricating oil pressure.
Clean hair filling of air cleaner on compressor.
Inspect compressor coupling bolts and parts.

Mechanical Parts.

Inspect axleboxes and grease if necessary.
Clean header tank level gauge if necessary.
Remove dirt from air side of radiators and ducting.
Oil door catches, hinges, etc.
Check fire extinguishers for weight.
Clean engine air filters.
Lubricate hand brake column and linkage.
Lubricate T.M. nose and lateral link pins.
Inspect draw and buffing gear.

3 monthly or 25 000 miles.

Monthly service plus :

Engine.

Air ports, Exhaust ports and manifold — Inspect for carbon deposit and if necessary clean.
Transfer valves — Remove, examine, dismantle and clean.
Cylinder lubricating plugs — Clean holes in liners and test oil supply.
Lubricating oil — Drain oil from base, clean and refill.
Fuel pump control levers — Inspect split pins and locking nuts.

Control Equipment.

E.P. Motor Switches — Clean switch contacts if necessary, lubricate and check.
Reversers — Clean and lubricate contacts and cylinders.
Starting contactors — Clean and check.
Starting, overload, current limit and E.F. relays — Clean and check.
All L.T. contactors — Clean and check.
Motor cut-out switch — Clean and check.
Load regulator — Clean and check, drain off surplus oil, and, if excessive, examine pistons.
Check ammeters and voltmeters for zero readings and reset if necessary.
Check operation of warning and shut-down devices.
Battery charging sockets — Check operation and lubricate hinge pins.
Battery isolating switch — Clean blades and lubricate hinges.
All control apparatus — Check tightness of connections and fixings.

Electrical Machines.

Blow out and inspect interiors of all machines as thoroughly as possible; check tightness of all brushgear bolts.

Check T.M. bolts securing axle caps, gearcases, axle shields and dust guards. Check lids of oil wells fit correctly.

Check lubricating yarn in T.M. axle caps is tightly packed. Add more if necessary.

Check for leakage from gearcase and suspension bearings.

Check T.M. external cables for chafing.

Check T.M. flexible bellows.

Examine T.M. suspension and lateral restraint links and check that the rubber bushes are clean and in good condition.

Check coupling between engine and main generator.

Brake and Air Equipment.

Check air system for leakage.

Test air and vacuum gauges against master gauges.

Inspect suction and delivery valves of exhauster and compressor.

Mechanical Parts.

Inspect engine generator mountings, check fixing bolts for radiators and piping.

Examine bogies shock absorbers for signs of leakage.

Lubricate window wipers.

6 monthly or 50 000 miles.

3 monthly service plus:

Engine.

Cylinder heads — Remove, decarbonise and clean out water space.

Pistons — Clean and examine tops.

Governor — Examine external linkage for wear and check freedom of movement.

Fuel pumps — Check pump rollers and levers for slackness and flats on rollers.

Exhaust pipes — Examine for carbon deposit and clean if necessary.

All chain drivers — Examine.

Lubricating oil pump — Examine and clean valve.

Sprayers — Clean and adjust.

Cooling water — Flush and clean system, treating for deposit if necessary and refill with treated water.

Lubricating oil — Flush system.

Control Equipment.

Master controllers — Check fingers, mechanical interlocking and lubricate.

All resistances — Blow out.

Interlocks — Adjust if necessary.

Control key switch panel — Remove cover and check switches and buttons.

Battery — Give a conditioning charge.

Megger test — (Excluding fuel gauge and speedometer).

Brake and Air Equipment.

Clean sand ejector chokes and strainers.

Drain exhauster and compressor sumps, clean oil strainers and refill.

Mechanical Parts.

Check wheel tread profiles (or in line with standard practice).

Check end float of axles in axleboxes, and axleboxes in guides.

Check cotter wear on bottom of bolster swing links.

Annually or 100 000 miles.

6 monthly service plus:

Engine.

Scavenge air coolers — Dismantle and clean thoroughly.

Pistons — Remove and clean, replacing worn rings, but preferably not more than two pressure rings per piston at the same time.

Water jackets — Clean out and repaint surfaces.

Connecting rod bearings — Take up large end clearance if necessary. Replace small end bush if clearance excessive.

Main bearings — Reset clearances, examine oil ducts and pipes.

All working parts — Refit worn pins, bushes, rollers etc. as required.

All nuts and bolts — Check for tightness.

Lubricating oil pump — Clean and examine.

Maximum and compression pressures — Check correct.

Lubricating oil priming pump — Dismantle, clean and examine.

Control Equipment.

Check that fuses are of correct rating.

Magnet valves — Remove valve interiors, clean and check.

Master controller — Repack ball bearings of main shafts.

Cab heaters — Replace short length of cable between heater and terminal box if insulation has perished.

Voltage regulator — Examine knife edge bearings.

Load regulator — Replace worn contacts and piston washers.

Hot plate — Clean base reflector.

Battery — Remove and clean. Recondition terminals and test.

Electrical Machines.

Lubricate armature bearings of all rotating machines on the locomotive. (This is provisional, depending on results of controlled observations).

Brake and Air Equipment.

Dismantle, clean, examine and lubricate as necessary all brake and air apparatus including exhauster and compressor. Renew all rubber parts in brake valves if necessary.

Mechanical Parts.

Thoroughly clean and inspect mechanical structure for signs of fatigue.

Clean and inspect centre pivots, side bearer faces, bolster thrust faces, brake pins and axlebox guides.

Inspect T.M. air ducts.

Remove and inspect radiator fan and keyway.

Grease air filter spring catches.

Remove compressor coupling for inspection and replacement of worn parts.

Lubricate hand brake gearboxes.

Clean oil section of radiators and piping.

Clean and flush fuel tank.

Overhaul and lubricate window wipers.

Top up mileage counter through oil filler and inspect.

Repack bearings of speedometer generator and inspect.

Clean and repaint battery boxes.

Dismantle T.M. nose and lateral link gear and examine pins for corrosion.

General overhaul.

(Every 3 years, or when necessary).

Engine.

With engine-generator set removed from locomotive, and generator removed, dismantle all moving parts (crankshaft only if necessary) recondition and adjust where necessary. Load test after reassembly with generator.

Control Equipment.

All insulation — Clean, and make good any damage.

E.P. Motor switches and reverser — Dismantle, clean, check, lubricate and replace piston washers.

Starting contactors and L.T. contactors — Replace worn hinge pins, etc. — Re-treat coils by external brushing.

Overload and E.F. relays — Replace latch wearing parts if necessary.

Master controller — Examine for mechanical wear.

Electrical Machines.

Remove all machines from their mountings and dismantle according to instructions covering the individual machines.

Examine all parts thoroughly and clean renovate or renew as required. When reassembled, machines should be run light long enough to ensure correct fitting of bearings. If necessary machines should be dried out and possibly revarnished and again dried out before going back into service.

Mechanical Parts.

Dismantle all parts, recondition and adjust where necessary.

FOREWORD.

QUESTION	*BRITISH RAILWAYS*							
1 (a) *Number of Diesel locomotives in normal service*								
Shunting	357	23	4	3				
Train hauling					1	1	2	3
Mixed traffic								
Number of Diesel locomotives on Building Programme								
Shunting	404 to end of year 1957							
Train hauling					171 from 800 H.P. to 2 300 H.P.			
Mixed traffic								
1 (b) *Characteristics of principal types of Diesel locomotives*								
Type	0-6-0	0-6-0	0-4-0	0-4-0	Bo-Bo	4-8-4 (Coupled	Co-Co	1 Co-Co 1
	T.C.	T.C.	T.C.	T.C.	T.C.	19 T.	T.C.	T.C.
Weight per axle	15.15	9.18	16.0	11.5	17.9	11 T. Bogie)	21.7	18.10
Method of transmission	E	M	H	M	E	M	E	E
Maximum speed (M.P.H.)	20	25.8	12	18.2	70	74	93	85
Tractive effort (lbs.)	35 000	16 850	21 500	10 800	34 500	34 500	41 400	48 000 50 000
Number of Diesel engines	1	1	1	1	1	4	1	1
Horse power (H.P.)	350	204	200	153	827	= 2 000	1 600	2 000 1 750
Nominal power of traction motors (H.P.)	270	—	—	—	620	—	1 068	1 380 1 212
Speed of traction motors (R.P.M.)	925	—	—		433	—	935	900 393
2 *Brief summary of the characteristics of the system-Gauge*	4' 8 1/2"							
Weight of rail	85 lbs/yd or 95 lbs/yd (B.H.) or 109 lbs/yd or 98 lbs/yd (F.B.) according to classification of line and age of track							
Gradient profile	From level to 1 in 70							
Track characteristics	Rails supported on chairs or baseplates; wooden or concrete sleepers spaced 24 to 60 ft.; stone or slag ballast superelevated on curves							
Nature and intensity of traffic	Passenger and freight (very heavy)							
Characteristics of shunting services	Flat. Gravity and hump yards							

NEW ZEALAND GOVERNMENT RAILWAYS							CEYLON GOVERNMENT RAILWAYS					
			25		10	36	1	8				
15	10 (Suburban)	42		15					17	5	5	4
De	Df	Dg	Ds	Ds	Ds	Ds	G1	G2	M1	M2	N1	P1
Bo-Bo	2-Co-Co-2	A1A-A1A	0-6-0	0-6-0	0-6-0	0-6-0	0-4-0	Bo-Bo	A1A-A1A	A1A-A1A	1-C-1	0-6-0
12.75 T.	11.5 T.	11.55 T.	12 T.	10 T.	10 T.	9.10 T.	T.C. 10.8	T.C. 13.10	T.C. 14.19	16 T.	9.3 T.	6.8 T.
E	E	E	M	M	M	M	E	E	E	E	H	M
60	60	60	24.5	25.7	25.8	25.8-30.5	15	20	55	60	30	19.5
30 000	48 900	28 900	—	—	—	—	11 200	35 000	33 700	—	20 150	9 000
1	1	1	1	1	1	1	1	1	1	1	1	1
660	1 500	750	260	250	240	204	—	—	—	—	—	—
460	1 050	520	—	—	—	—	—	492	784	—	—	—
2 310	2 220	—	—	—	—	—	—	1 600	470	—	—	—
to 100 lbs.							Broad = 5' 6", Narrow = 2' 6"					
um 1 in 41							Broad gauge 72-90 lbs/yd in 30 ft. and 45 ft. lengths					
pported on bed plates, hardwood sleepers spaced 2'3" to 2'6" s, crushed metal ballast with a minimum of 9"depth under s							Maximum 1 in 44					
l and mixed. Approximately 10 000 tons daily							Metal ballasted with rails spiked to wooden sleepers					
shunting locomotives used at the larger stations							—					
							Shunting at goods sheds and goods yards					

QUESTION	*JAPAN*		*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*		*EAST AFRICAN RAILWAYS*		*NIGERIAN RAILWAYS*
1 (a) *Number of Diesel locomotives in normal service*							
Shunting			8 558		Shunting only (5.54% of total locomotive stock)		
Train hauling	3			7 729			
Mixed traffic		3		885			5
Number of Diesel locomotives on Building Programme							
Shunting							
Train hauling							
Mixed traffic							6
1 (b) *Characteristics of principal types of Diesel locomotives*							
Type	DD50(Bo-Bo)	D11 (B-B)	Shunting (Bo-Bo)	Main Line (Co-Co)	0-6-0	0-6-0	Bo-Bo
Weight per axle	15.86 T.	8.49 T.	49 500-60 000 lbs.	50 000-64 500 lbs.	—	—	13 Tons
Method of transmission	E	H	E	E	M	M	E
Maximum speed (M.P.H.)	90 Km/H	60 Km/H	65	117	15	26.2	55
Tractive effort (lbs.)	13 900	8 400	78 750	52 500	—	—	—
Number of Diesel engines	1	2	1	1	1	1	1
Horse power (H.P.)	—	—	—	—	80	200	—
Nominal power of traction motors (H.P.)	900	= 320	600 volt variable speed traction motors and required gear ratio in areas in which locomotives operate		—	—	—
Speed of traction motors (R.P.M.)	800	1 500			—	—	—
2 *Brief summary of the characteristics of the system*							
Gauge	1 067 mm		4' 8 ½''				3' 6''
Weight of rail	50 Kg/m or 37 Kg/m		100 lbs. to 155 lbs.				60 R.B.S.F.B.
Gradient profile	Level to 2.5 %		Approx. 0.5 % to maximum 3.5 %. Treated wood ties 22-29 to 39 ft. rail length				1.25 % curve 6°; 1.0 % curve 8°.
Track characteristics	Single tracked secondary line (many grades and tunnels)		Ballast crushed rock, gravel, slag, chats, etc.				Steel sleepers. Rail clip fastenin A.B. and K. clips stone ballast
Nature and intensity of traffic	77 Passenger and freight trains per day (4 hauled by Diesels)		From several trains per day to several hundred per day		The shunting service is mainly in the port areas, quayside and marshalling yards where, until certain construction schemes are finalised there is at present some degree of congestion		Ground nuts and co ton exports, gener cargo imports. 25 000 net ton mile per month up an 45 000 down.
Characteristics of shunting services	Freight shunting and making up trains		Both flat yards and hump yards				Normal train ma shalling.

NORWAY		REPUBLIC OF IRELAND					NEW SOUTH WALES				
		5	3			12 (delivered)	2				
1	1				2			20			
									10		
		19		12	34	48				6	6
Di 2 (C)	Co-Co (NOHAB)	0-6-0	Bo-Bo	A1A — A1A	Bo-Bo	Co-Co	Bo-Bo	A1A-A1A	Bo-Bo	Co-Co	Co-Co
1) ted axle load = 15 tons		17.65 T.	5.75 T.	14.5 T.	20 T.	14.5 T.	11 T.	18.5 T.	20.5 T.	18.2 T.	19 T.
H	E	E	M	E	E	E	E	E	E	E	E
50 Km/h — Shunting m/h 80 Km/h — Trains		25	32	75	60	75	35	75	57	70	70
—	—	—	—	—	—	—	25 000	46 000	22 800 (continuous rating)	73 200	76 600
1	1	1	1	1	1	1	2	1	2	1	1
00 575/750	1 750						= 380	1 600	= 1 000	1 600	1 750
—	—	274 amps	—	295 amps	—	295 amps	380	2 240	700	—	—
—	835	530 volts	—	670 volts	—	670 volts	—	—	357	—	—
		5' 3"									
/m		70 - 90 lbs.									
n/m		Level to 1/60 on main line Level to 1/50 on branch lines									
len sleepers - sleeper distance m. Minimum curve radius n; crushed stone ballast		Wooden sleepers, stone ballast									
- about 3 000 train kilometers ilometer of line		Medium - light intensity									
—		Normal - no hump shunting									

NOT REPORTED

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAYS*
CHOICE OF CHARACTERISTICS **A. — Train haulage.**		
1. *If the operation of a district calls for a high degree of power, do you prefer high power locomotives or not ?*	A single locomotive of given power is generally cheaper in first cost than two separate locomotives each of half the power. The answer as to which arrangement is preferable depends on the user which can be obtained from the different combinations.	The rail weights are very moderate, especially on secondary lines. For this reason the use of high powered units is impracticable and we are compelled to adopt medium and low powered units working in multiple where necessary.
2. *If you favour using coupled locomotives, should there be corridor connection between the two units ?*	Yes, in order that attention may be given to the steam heating boilers and a check made of the equipment when running. Also advantageous in the event of fire.	Yes. For main line running the locomotive crew consists of two men. Use will be made of the second member to undertake periodical engine and equipment inspections. Corridors should therefore be provided.
3. *Are certain of your locomotives made up of several units ?*	No.	This practice will be adopted widely on this system.
Do you envisage the possible use of such locomotives ?	Yes.	—
4. *Do you consider that a single type of locomotive could, satisfactorily, cope with a varying range of gradients, loads and speeds in the haulage of different categories of trains; if not, how many types do you consider should be constructed—*	A single type of locomotive could not satisfy all requirements (gradients etc.) and come within the axle load limits, but there are diesel locomotives being built which could possibly haul the different categories of trains. It has not yet been decided which type is to be used, i.e. one locomotive with the appropriate horse power or two whose total horsepower equals one.	A single type of locomotive would involve too high a capital expenditure as the basic unit would have to be a low powered engine capable of running on all tracks where diesel operation is contemplated. In consequence, two types of locomotives are required, one with an axleload of 12½-14 tons. The former (up to 1 500 H.P.) would be used on main lines and the latter (up to 750 H.P.) on secondary tracks, with an axle load of 11-11½ tons.
(a) *for main lines ?*	(a) 2 Types, 3 000-3 600 H.P. and 2 000-2 400 H.P.	
(b) *for secondary lines ?*	(b) 3 Types, 750-1 000 H.P., 1 000-1 200 H.P. and 1 500-1 700 H.P.	
How do you justify your choice ?	This choice is due to the varying nature of traffic encountered on British Railways with fine limits between trains.	
5. *Are your diesel locomotives used both for passenger and freight services ?* *If so, what is gained by this combination of duties ?*	Yes, if one type of locomotive may work passenger and freight, the number of types of diesel locomotives is considerably reduced; also, the holding of spare parts is reduced. One type of diesel locomotive for passenger and freight will give a more economic diagramming, with consequent increased utilisation.	No. Express passenger services are exclusively covered by a modern fleet of steam locomotives. With axleload restrictions it is not possible to include a steam heating boiler on diesel locomotives.

EYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
ll depend on the circumstances. s for heavy haulage on level high powered single locomo- desirable. If the power is d for steep continuous gra- then low powered locomotives together are suitable. The ques- one of time rating of the tractive required. On level runs high effort is reached only for start- d therefore such high ratings can ined by sanding, but on contin- ow tractive effort it is desirable high adhesive factor by distrib- he tractive effort over a larger of axles.	Prefer high powered locomotives, as operation is simplified and costs of manufacture and maintenance are cheaper. It is true, however, high power is bulky and difficult to install in limited space. As the weight increases the number of axles must be increased to keep the axle load within the specified value, resulting in more complicated axle arrangements and lower running efficiency. The number of locomotives to be put into service can be adjusted according to train load, enabling flexible and efficient operation.	High power requires fewer locomotives resulting in lower overall maintenance costs.
No.	Yes. Because the corridor connection between the two units makes it easier to inspect and temporarily repair the engines and any other equipment while the locomotives are running.	It is desirable to provide corridor connection between two or more units coupled together to allow personnel to pass between units while in motion should the necessity arise.
No.	No.	Yes.
No.	Not at present.	Yes.
he best arrangement is one unit pable of multiple working. For ailway the power should be P. per locomotive at rail. The nit locomotive can be used for g as we have no hump shunting.	No.	Yes. Locomotive units of from 1 000 H.P. to 2 000 H.P. could be used in multiple for heavy trains and heavy grades while light trains could be handled by single units.
	(a) Main lines are included in the programme of electrification which is under way. (b) Three types, 600 H.P., 1 200 H.P. and 2 000 H.P. The first two types are sufficient for our railways, but if the increase in traffic in the future is taken into consideration, the locomotive at 2 000 H.P. capacity will be necessary. This selection has been based on the performance of steam locomotives now in actual service on our lines.	
or passenger and mixed traffic s thereby reducing the number of nt types necessary.	Bo-Bo type are used. The advantages are, reduction in varieties of types, simplifies maintenance and increases operation efficiency.	Yes. Results in higher availability and fewer locomotives.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
CHOICE OF CHARACTERISTICS **A. — Train haulage.**		
1. *If the operation of a district calls for a high degree of power, do you prefer high power locomotives or not ?*	—	Advantageous to use lower power locom tives than that which the district calls as greater flexibility of operation is obtain with the minimum of varying types of lo motives. With two or more locomoti working in multiple unit there is less cha of a complete failure as should one u fail this may be isolated and the tra continue in service, at a lower speed on t remaining unit or units.
2. *If you favour using coupled locomotives, should there be corridor connection between the two units ?*	—	Access between locomotives working multiple unit is necessary in order to affo train crews the facility of carrying o inspections of power equipment or traili units. The additional cost involved double-cab locomotives is justified by t greater accessibility obtained whilst t locomotives are in service.
3. *Are certain of your locomotives made up of several units ?*	—	Two locomotives have been used in m tiple unit but this practice has been su pended owing to the impractibility at t moment of marshalling fully loaded tra at the correct time.
Do you envisage the possible use of such locomotives ?	—	Use may be made of this procedure shou traffic warrant multiple unit working.
4. *Do you consider that a single type of locomotive could, satisfactorily, cope with a varying range of gradients, loads and speeds in the haulage of different categories of trains; if not, how many types do you consider should be constructed :* (a) *for main lines ?* (b) *for secondary lines ?* *How do you justify your choice ?*	—	One type of locomotive could be capab of working main-line trains whether pa senger, mixed or freight, but smaller loc motives should be used for secondary li work and for purely shunting duties. H the Nigerian Railways the types requir would be as follows :— (a) Main-line — 1 100 H.P. (b) Secondary — 750 H.P. Shunting — 350 H.P.
5. *Are your diesel locomotives used both for passenger and freight services ?* *If so, what is gained by this combination of duties ?*	—	Yes. The locomotives at present in serv and on order are capable of both the duties where the sections of the line ha a maximum speed of 35 m.p.h.

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
prefer high power locomotives, as ling of locomotives always demands and involves risk of retardings.	Conditions favour single locomotive operation.	—
No.	No.	—
but the question is under consideration.	No.	—
nd (b). On the Norwegian State Rail- s (both on main lines and on secondary) there is a clear difference between with rail of 35 kg/m and more, and rails of less than 35 kg/m. can be built a locomotive C-C, reliable rvice, with an axle load of 13 tons and 0 H.P. and with a maximum speed of km/h, a single type should probably be cient.	No. Three types for both (a) and (b) of 1 200 H.P., 550 H.P. and 400 H.P. and a small type of 135 H.P. for minor branches.	—
assumed that the adhesion weight of diesel locomotives should be so great, the locomotives can be used both for engers and for freight services. In this ner a better utilisation of the locomo- is possible.	Yes. Better utilisation.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
6. *How do you propose overcoming the problem of heating in the case of diesel locomotives operating a passenger service ?* *What reasons have you for this preference ?* *Is the system installed on the locomotives or on a special vehicle ?*	Steam heating. All passenger stock not life expired is fitted for steam heating and it is not economical to convert to other types of heating. The heating system is installed on the locomotive. The ultimate intention is to heat the trains by electricity supplied from the locomotive either by its own power unit or by separate diesel generator sets.	As boilers cannot be provided on the locomotives steam for heating would be supplied from a separate power van in the event of diesels taking over passenger services. This would enable diesels to be rostered in passenger or freight working without restriction.
B. — **Shunting service.**		
7. *What in your opinion, should be the power of diesel locomotives for the various types of shunting to be performed ?*	Shunting and transfer of wagons 350 H.P. and 200 H.P. Small stations, etc., 150 H.P. to 165 H.P.	Coupling rod drive 0-4-0 diesel mechanical shunters of 100-150 H.P. on branch lines and these undertake short runs of up to 5 miles. Operation in yard by one man and two on the main line. At larger centres, rod drive diesels of 204-260 H.P. are used for shunting. In the largest yards 260 H.P. diesels will be replaced by 350-500 H.P. units.
8. *On the basis of these considerations, how many classes of locomotives are provided or will be provided for shunting ?*	350 H.P. diesel electric 0-6-0. 200 H.P. diesel mechanical or hydraulic 0-6-0. 150-165 H.P. diesel mechanical 0-4-0.	Power . . . . 150 H.P. / 204 H.P. / 260 H.P. / 350-500 H.P. Wheel arrangement . . . . 0-4-0 / 0-6-0 / 0-6-0 / Bo-Bo or 0-8-0 Axleload (tons) . 9½ / 10 / 12 / 12(?) Max.Speed(m.p.h.) 22.1 / 28.1 / 24.5 / 25-30 Tractive Effort at 5 mph (lb) . . 7 950 / 12 100 / 15 600 / 22 000 (approx.) Tractive Effort at max. speed . . 1 945 / 2 170 / 2 970 / ?
C. — **All services (train haulage and shunting).**		
10. *What factors do you think should be taken into consideration when selecting the scope of operation or the period of transition for Diesel locomotion ?*	Sufficient power within the axle loading covering the sections on lines over which diesel operation is required. The factors which have to be taken into consideration are : (a) The greater economies which can be obtained from diesel traction arising from high utilisation. (b) The rate of progress of electrification. (c) The rate at which steam locomotives can be economically disposed of.	(1) Finance for the purchase of the locomotives and building of suitable depots for servicing running repairs and overhauls. (2) Time to train operating and maintenance staff. In the case of the latter as many fitters as possible are trained in railcar depots in anticipation of extended dieselisation. Selected tradesmen were also sent to builder's works. It is intended to completely dieselise sections as far as possible rather than to have steam and diesels working in parallel. However, the operation of passenger expresses by steam locomotives is a qualification of this policy.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
—	Steam heating, because all the existing passenger stock is equipped with the steam heating system and it is not economical to install electric heaters. Steam boiler preferably installed on diesel locomotives used exclusively on passenger service. In the case of other services, the system is preferably installed on a special vehicle "heater car".	Steam heat boilers which are dependable and simple to operate. Boilers installed on the locomotive.
—	1 000 H.P. for hump shunting. 600 H.P. for shunting in sidings and large stations, etc. 300 H.P. for shunting at small stations, warehouses, workshops, etc.	1 000 H.P. - 1 600 H.P. for all switching except at small stations, warehouses, workshops or depots where 600 H.P. should be sufficient.
—	Wide use of diesel locomotives for shunting purposes is not contemplated at present on account of the large stock of steam locomotives in service.	Three classes — 600 H.P., 1 000 H.P. and 1 600 H.P.
period of transition will entirely d on training facilities and the to which the existing steam locoes can be worked economically and the extent to which dieselisation be carried out due to strategic derations.	(a) Whether or not the section is such that a "long run" is possible. (b) Whether or not the section is abundant in tunnels. (c) Whether or not the section necessitates the haul of heavy trains. (d) Whether or not an enormous amount of money is needed for the section when it is electrified. (e) Traffic volume. (f) How to dispose of the steam locomotives.	Profile of the section, average train weight, timetable showing required running time, necessary station stop, speed restrictions, etc.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
6. *How do you propose overcoming the problem of heating in the case of diesel locomotives operating a passenger service ?* *What reasons have you for this preference ?* *Is the system installed on the locomotives or on a special vehicle ?*	— —	— —
B. — Shunting service.		
7. *What in your opinion, should be the power of diesel locomotives for the various types of shunting to be performed ?*	Have no practical knowledge of the diesel locomotive characteristics required for hump shunting work. In port areas 200 H.P. diesel mechanical locomotives, with additional 300 and 500 H.P. diesel hydraulic (Voith type) for congested areas. 888 H.P. hydraulic locomotive for wagon transfer at Mombasa Port and heavy loads at Nairobi (altitude 5 500 ft.). 300 H.P. hydraulic locomotives for up country clearances. 80 H.P. diesel mechanical used at small stations.	(i) 350 B.H.P. or 400 B.H.P. diesel electr locomotives with double reduction gea between traction motors and axles shoul be used in normal shunting yards. (ii) Where transfer work is required a loc motive of 500/600 B.H.P. would be consi ered sufficient. (iii) A locomotive of say, 200 B.H.P. wou be sufficient for light shunting at statio warehouses, workshops or depots.
8. *On the basis of these considerations, how many classes of locomotives are provided or will be provided for shunting ?*	When our present orders are delivered we will have a total of five classes. 80 H.P. diesel mechanical. 200 H.P. diesel mechanical (fluid drive). 300, 500 and 888 H.P. diesel hydraulic (Voith type) for shunting and transfer work.	No consideration being given to emplo ment of shunting locomotives.
C. — All services (train haulage and shunting).		
10. *What factors do you think should be taken into consideration when selecting the scope of operation or the period of transition for Diesel locomotion ?*	—	In Nigeria the scope of operation for Dies locomotion is at present restricted by t acute shortage of technicians thus hamperi efficient maintenance and this also has bearing on the period of transition in re pect of any further increase in dieselisatio

NORWAY	REPUBLIC OF IRELAND	NEW SOUTH WALES
team heating boiler is fitted on the type and a boiler truck for heating has used. On the NOHAB locomotive, a l steam generator for train heating talled. How the problem of heating be solved in the future is not yet ed on. However, in view of the pro- electrification, the possibility of use ctric heating has been discussed. Then, e event of an electrical failure on tain lines, special heating equipment sting of a diesel engine and suitable ic generator could be installed in a ge van, thus keeping to one type of ng in carriages.	Steam heating is most economical. The boilers are installed in special vehicles with luggage carrying capacity in addition.	—
agreed to one type of locomotive of t 600 H.P. and an adhesion weight of) tons (and in addition a shunting trac- ype of two axles).	Large engines of 500 H.P. for transfer and ordinary shunting. 400 H.P. and 135 H.P. for yard shunting.	—
classes — 600 H.P. locomotive and axle type shunting tractor.	Three classes — 500 H.P. diesel electric. 400 H.P. diesel electric. 135 H.P. diesel mechanical.	—
factor determining the scope of opera- of the train locomotives, which ought e 500 to 1 000 km is the running nce of the trains.	The whole cost of operation with steam should be investigated including permanent way and traffic operating costs as well as locomotive running and C.M.E. Depart- ment costs.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
11. *What axle arrangements have you adopted or do you propose adopting for :* (a) *train haulage on main lines ?*	(a) 1Co-Co 1, Co-Co and Bo-Bo at present, but the final solution will be influenced by questions of bridge loading and track maintenance.	The "De" Class (Bo-Bo) 12¾ ton axle loads / The "Da" Class (A1A-A1A) 14 tons axle loads } restricted to main line The "Df" Class (2Co-Co2) 11.5 ton axle loads ha availability on all main and secondary lines. The "Dg" Class (A1A-A1A) 15 tons axle loads available over light lines.
(b) *shunting ?*	(b) 0-6-0 for 200 H.P. to 350 H.P. — 0-4-0 up to 200 H.P.	For shunting services we have adopted 0-4-0 an 0-6-0 units with coupling rod drives.
Have these arrangements been influenced by the general characteristics of the track structure ?	These arrangements have been influenced by the general characteristics of the track and tractive effort required.	Track characteristics have not been a limitatio any more than with our standard steam shunte
What factor or what axle arrangements ensure economy in track maintenance ?	Unable to say what economy in track maintenance there would be at the present time.	It has not been decided what the arrangements t the 350-500 H.P. diesels will be. If diesel electri it will almost certainly be Bo-Bo; if diesel hydrau lic 0-8-0 or 2-8-0.
12. *For secondary lines, do you consider it necessary or desirable to specialise in locomotives for train haulage and others for shunting ?*	Mixed traffic locomotives are desirable for train haulage and shunting purposes.	Where the volume of shunting at any secondar line station is sufficient to warrant placing a dies shunter there, one will be provided. Where the is only a little shunting this is done by the trai locomotive.
13. *Do you favour the greatest possible degree of standardisation by using only the lowest possible number of types of diesel locomotives and engines ?*	Standard types are desirable with interchangeable connections and couplings.	Rationalisation of locomotive stock normall would be expected to be most vigorously pursue after diesel working had been thoroughly estab lished. The point is not considered to be a major one a usually different types of main line locomotive can be segregated into separate operating areas.
14. *In the case of a particular locomotive, do you think it preferable to use a single engine or several engines of lower power ?* *What type of engine do you prefer — slow or fast — (two stroke or four stroke) ?*	A single type engine is preferable to several engines of lower power. It is considered that a single engine is more economical from the maintenance and installation point of view. Little experience with the two stroke engines but it is considered that the four stroke slow or fast running type of engine is preferred dependent on axle weight and route availability requirements.	One engine per unit is preferred because suc locomotives are much cheaper and also lighte Where multiple unit operation is widely adopte failure of one unit does not immobilise the trai so the two-engine locomotive has no advantag in this respect. Slow engines are preferred to fast running. The are considered more reliable in service and mai tenance costs are lower. We have no particular preference on the questio of two- or four-stroke engines. Much mo importance is attached to the reliability of th diesel engines.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
(a) A1A-A1A.	(a) None for main-line work, for secondary lines the axle arrangement is Bo-Bo and may consider Co-Co, A1A-A1A etc. for the future.	(a) 4 and 6 wheel trucks.
(b) Bo-Bo.	(b) B-B is the type in use and is satisfactory and we expect to keep to this axle arrangement.	(b) 4 and 6 wheel trucks.
	The axle arrangements adopted have not been influenced by the general characteristics of the track structure, excepting by permissible axle load.	General characteristics of the track structure has not necessarily influenced the selection of axle arrangements.
	Light axle load; reduced side thrust of wheels against the rail; reduced striking angle between wheel and rail at curve. Unsprung weight reduced to the minimum.	With light rail 6 wheel trucks are most favourable to the track structure.
	In the light of above factors, a swing bolster truck, especially the Bo-Bo type is most desirable for ensuring economy in track maintenance.	
No.	No, if traffic volume is small. If heavy, it is desirable to specialise in locomotives for train haulage and others for shunting.	No.
Yes.	Yes.	Yes.
Single.	Single engine, on account of manufacturing and maintenance costs being cheaper than on a locomotive with 2 sets of power equipment, excepting where only a few locomotives are to be built and at the same time low powered engines are used in quantity for other purposes it may be advisable to equip the locomotive with several such engines. Prefer a fast running engine as it is less bulky and lighter.	Single engine. The least possible number of engines required for the operation would result in the lowest possible cost and lower maintenance cost. Proper maintenance would result in good operating reliability.
	Appears to be no decisive factor justifying preference for two or four stroke engines.	Prefer two-cycle engines.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
11. *What axle arrangements have you adopted or do you propose adopting for :* (a) *train haulage on main lines ?* (b) *shunting ?* *Have these arrangements been influenced by the general characteristics of the track structure ?* *What factor or what axle arrangements ensure economy in track maintenance ?*	(a) An 8-coupled arrangement will be used on the 888 H.P. transfer locomotives and will also be used on the 500 and 300 H.P. shunting locomotives. (b) A 6-coupled arrangement is used on the locomotives in the smaller classes, i.e. 80 and 200 H.P. These wheel arrangements and spacings, were adopted after careful consideration of rail and sleeper stresses induced in the various flat bottom rail weights, and by a co-ordination of axles-load, wheel arrangements, wheel spacing, in calculations, the heaviest axle load possible over the lightest track these locomotives will be required to work on, was decided.	Axle arrangements adopted for the on type of main-line locomotive in use on th system are Bo-Bo. Shunting locomotives a not yet employed.
12. *For secondary lines, do you consider it necessary or desirable to specialise in locomotives for train haulage and others for shunting ?*	—	Not applicable to Nigerian Railways.
13. *Do you favour the greatest possible degree of standardisation by using only the lowest possible number of types of diesel locomotives and engines ?*	It has been our policy to limit the number of different manufacturers' engines in service to as few as possible, commensurate with delivery prospects and financial outlay.	The greatest possible degree of standard isation should certainly be obtained bo from the point of reduction of number spares to be stocked and also in the redu tion of maintenance difficulties.
14. *In the case of a particular locomotive, do you think it preferable to use a single engine or several engines of lower power ?* *What type of engine do you prefer — slow or fast — (two stroke or four stroke) ?*	We have not, on any diesel locomotive ordered to date, considered it necessary to install more than one engine, nor would it be wise with the labour available in East Africa to contemplate unnecessary complications of this nature. All engines in service are medium/high speed four stroke engines, to allow us to have the highest reliable horse power for the least weight to keep within our axle loading limits.	If is felt that on locomotives of a particul type, no advantage is gained by using mo than one engine per locomotive as fi costs would be increased considerabl maintenance costs would be increased wi no improvement in locomotive flexibilit Reliability would also be considerab decreased. No actual experience of mu engine locomotives on Nigerian Railway A medium speed engine is preferred fro the point of view that this type of engi is more robust than the smaller high spe type of engine. It is considered that t stresses in the high speed engine are great in proportion to those obtaining in t medium speed engine. No experience two stroke engines on Nigerian Railway

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
or Di 1 1' B B 1' or the NOHAB locomotive Co' Co'	(a) Co-Co, Bo-Bo and 0-6-0.	—
or Di 2 C	(b) 0-6-0 and 0-4-0.	
rain haulage on main lines we consider comotive with 3 axle bogies with all driven as most suited for Norwegian tions, as we need the whole weight of ocomotive as adhesion weight because eavy gradients. For the shunting ser- a 3-axled rigid frame locomotive is able.	The axle weight has been reduced to under 14.5 tons to enable lighter track to be used.	
No.	For the minor branch lines a very cheap unit is essential and this leads to the introduction of the small 0-6-0 and 0-4-0 types.	—
Yes.	Yes.	—
ngle engine results in lowest purchase With regard to the reliability in ser- and the expenditures of fuel, it will referable to use 2 engines. At partial only one engine can be used while other rests. Our limited experience of l engines for rail traction points to act that the slow running engines are robust in service. suggest that in the future a slow run- 2 stroke engine may prove to be the for railway service !	A single engine is cheaper in first cost and maintenance and as it could be used without exceeding the maximum axle loading, this type was adopted. Too early to express an opinion, as two stroke, slow speed, four stroke low speed, and four stroke high speed engines are in use.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
15. *Do you consider it expedient to investigate the use of lower efficiency diesel engines which are more simple, less costly, do not require a high standard of maintenance, etc., which is offset by a lower degree of engine performance?*	No experience with the lower efficiency diesel engines on rail traction.	Other things being equal, the more efficient diesel engine would naturally be preferred but on this system precedence will be given to reliability and low maintenance costs. In our view any savings in fuel costs that might be achieved could easily be swamped by increased capital and maintenance costs quite apart from indirect costs incurred through traffic hold-ups.
— have you investigated construction methods that would allow for standardisation of engine parts and component parts?	As far as possible components should be interchangeable with different types of locomotives — such as pumps, injectors, self-starters, compressors and radiators.	At the moment our main-line diesel power is engined with one make only so we have no actual experience on this point.
16. *On diesel locomotives, do you prefer a single driving cab in the centre, or a cab at each end, or a single cab at one end?*	Shunting locomotives — single cab at one end. Main-line locomotives up to 1 000 H.P. — cab at one end; over 1 000 H.P. cab at each end.	Where locomotive usage is of single units there is a case for cabs at both ends, but if the units are used on long runs the terminal loss of time through having to turn is negligible and a second cab is not warranted. Where locomotive working is predominantly of units running in multiple one cab at or near the end is sufficient. On locomotives below 750 H.P. a single cab at one end is required.
— for shunting locomotives?	Yes.	
— for locomotives hauling trains?	Yes.	
17. *Do you favour the use of the deadman's handle?*	Yes.	This is regarded as necessary where one-man operation is the rule. This (or similar equipment) is provided on all our diesel locomotives over 200 H.P. The smaller 150 and 100 H.P. shunters are not provided with DM equipment as they are engaged only intermittently on station shunting work and local goods transfer services. In the latter case two men ride on the locomotive when on the main line.
— for shunting services?	Yes.	
— for train haulage services?	Yes.	
18. *What type of fire fighting equipment do you favour for diesel locomotives?*	Automatic or remote control extinguisher, with the addition of a portable extinguisher in each cab. The former are $C.O_2$ gas type and $C.O_2$ water type for main line locomotives.	For engine room fires carbon dioxide is sprayed from nozzles in the roof. Fifty-pound bottles are carried in the nose of the 1 500 H.P. diesels to supply the gas and are piped to the discharge nozzles. Operation is manual from a cock in the cab of the locomotive. Fire detection apparatus is also fitted.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
No.	Yes.	No.
Yes.	No.	—
ng locomotives. — Cabin at one ly or at the centre. notives hauling trains. — Cabin at nd or at the centre.	Shunting. — Single cab at one end on single-engined locomotives. A single cab in the centre in the case of two-engined locomotives, in both cases the engine room will be preferably the "hood" type. Train Haul. — Prefer cab at each end.	Prefer cab at one end for— shunting locomotives; road haul locomotives.
No. No.	No. No. } The driver is always accompanied by an assistant driver.	Do not favour the use of "deadman's" handle for shunting locomotives. Do favour its use for road haul locomotives especially those used exclusively on passenger services.
Portable.	We advocate portable fire extinguishers using chemicals.	Favour portable extinguishers with remote control. Both using foam.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
15. *Do you consider it expedient to investigate the use of lower efficiency diesel engines which are more simple, less costly, do not require a high standard of maintenance, etc., which is offset by a lower degree of engine performance?*	Except in the small size diesel locomotives there is no case in East Africa for slow speed engines as our light axle load restriction makes it imperative that light high output engines be used.	It might be of interest to investigate th use of a lower efficiency engine giving lower degree of engine performance, bu it is felt that the present high efficienc engines are sufficiently reliable not to wa rant a great expenditure on this investiga tion. Present day running maintenance o diesel engines need not amount to a grea amount of skilled work, being mainly con cerned with the examination and cleanin of filters, etc.
— have you investigated construction methods that would allow for standardisation of engine parts and component parts ?	With our present small number of diesels widely dispersed, very little can be done to improve maintenance facilities by exchanging major components. There has, however, been standardisation on some of the items enumerated.	No investigation has been carried out int construction methods to ensure greate interchangeability of engine and electrica parts, but first thoughts show that thi would be an admirable practice.
16. *On diesel locomotives, do you prefer a single driving cab in the centre, or a cab at each end, or a single cab at one end ?* *— for shunting locomotives?* *— for locomotives hauling trains ?*	All the shunting and transfer locomotives in use and on order, i.e. in the range of 80 H.P. — 888 H.P. are fitted with one end cab.	For simplicity of constructions, shuntin locomotives should have a single cab at on end. The visibility obtainable is quit sufficient for normal shunting work. On this type of locomotive where single units of large B.H.P. are employed, a dri ving cab at each end is considered prefer able with access between cabs through th locomotives. For secondary line locomo tives it is thought that a single cab at on end would be sufficient.
17. *Do you favour the use of the deadman's handle ?* *— for shunting services ?* *— for train haulage services?*	Consideration has been given to the use of a "deadman's handle" and it has been decided that for shunting duties or where two members of the staff are required on the footplate, it is not really necessary.	On shunting locomotives operated by one man only, the use of "deadman's handle o pedal" is essential. On single cab locomotives where the firem man or asst. driver cannot leave the ca whilst the locomotives are in motion thi "deadman's handle" is not considered necessary. Where double cab locomotives are employed and where a fireman may leave the driving cab to carry out an inter nal inspection, it is essential that "dead man" feature be fitted. Where single ca locomotives with one man operation ar used, the "deadman's handle" should b fitted.
18. *What type of fire fighting equipment do you favour for diesel locomotives ?*	To cover diesel locomotives required to shunt petrol tank wagons, and work in areas of high fire risk, a fixed carbon-dioxide system supplemented by carbon-tetrachloride extinguishers will best meet our needs. This is in addition to the manufacturers exhaust flame-proofing arrangements.	It is considered that a fixed installation preferable for fire fighting equipment – this equipment to be manually operated from the cab and to be possibly worked in conjunction with warning apparatus indi ating, in the cab or cabs, the presence o fire. It is preferable that Co_2 gas shou be used for extinguishing internal fires an that the "Pyrene" type extinguisher b carried for external fires.

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
—	—	—
No.	No.	—
shunting locomotives only a single ng cabin, preferably at the middle. rain hauling locomotives, driving cabins ach end in order to obtain the best ble visibility and to avoid the neces- to turn the locomotive.	Single cab for light engines — for shunting locomotives. Double — for locomotives hauling trains.	—
regard to one man service, we consider 'deadman's" device necessary for train ce as well as for shunting service.	Yes. Yes. Yes.	—
diesel locomotives are fitted with port- fire extinguishers for carbon dioxide .	Portable.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
METHOD OF TRANSMISSION		
20. *In the light of your experience and in all investigations made by your administration, what, in your opinion, are the respective fields of use for the various methods of transmission, mechanical, hydro-mechanical, hydraulic and electric? What are their advantages and disadvantages?*	Mechanical, hydraulic and electric transmissions are in use. The latter preponderates but we have not yet sufficient experience to assess the advantages and disadvantages of the other two types of transmission on comparative duties.	Mechanical transmission — good either for pa or full loads. Hydraulic transmission — efficient for low torqu and inefficient for high torque conversion ratio and low road speeds. Electric transmission — efficient over a wide rang of torque conversion ratios and at full loads inefficient on part loads; very heavy, bulky an expensive compared with other types. Maintenanc costs, however, are much lower. Driving is good for all types. Efficiency of mechanical is high; hydraulic poo and electric moderate. Reliability of mechanical is fair; hydraulic poo and electric good. Mechanical and hydraulic transmission only suitable for engines up to 250-300 H.P. Mechanical considered best. Electric transmission is favoured for handling over 500 H.P. Consideration is being given to adopting hydro-mechanical transmission for 350-500 H.P. diesel shunters.
21. *In the case of mechanical, hydro-mechanical or hydraulic transmission, what system of axle drive do you favour in the light of your experience?*	So far as mechanical drive is concerned, a gearbox with jackshaft and final drive by coupling rods is the most widely used although one main line locomotive has been in operation for several years with the "Fell" type of mechanical drive. Lower powered shunting locomotives with hydraulic transmission also have the jackshaft and side rod drive but for main line duties and higher powers, cardan shaft drive on to the driving axles will be the subject of a large scale experiment.	Only our diesel shunters (100-260 H.P.) come in this group. Rod drive with jackshaft is used in all cases and has proved very satisfactory. These locomotives normally operate at only low speeds but at Christchurch 204 H.P. locomotives are sometimes used to work light suburban passenger services in an electrified area on Sundays when there is no goods traffic. By this means the sub-station can shut down. These services require speeds of up to 25 m.p.h. The locomotives are somewhat underpowered for the job but the rod drive is no source of difficulty. Our railcars with engines of 115-250 H.P. have spiral bevel drive to the axles and this has proved satisfactory. Chain drive has never been considered.
22. *In the case of electric transmission, what arrangements do you advocate to obtain the best adhesion coefficient, from the point of view of:* (a) *electrical connection of the traction motors if the locomotive has independent axles?* (b) *mechanical connection between the axles in the alternative case?*	Parallel connection of motors is preferred where circumstances warrant the additional cost which sometimes occurs. Mechanical coupling has given good results with series connection but the parallel connection has also been used. The choice depends on what is the most economical arrangement for providing the required tractive effort appropriate to the speeds and loads.	The traction motors are permanently connected with two motors in series. Four-motor locomotives have therefore two parallel groupings and six-motor locomotives, three parallel groupings. Three weak field positions are provided. Our main-line diesels (individual axle drive) are fitted with electrical wheel-slip indicators. We find the only way to stop a wheel from spinning is to cut off the power for a short interval. The diesel mechanical shunters have rod drive and 100 % adhesion. Wheel slip is not a problem with these units which hold the rails well.

CEYLON GOVERNMENT RAILWAYS	JAPAN	U.S.A. ASSOCIATION OF AMERICAN RAILROADS
ult at present to make a choice en any of these as various types of nission systems have to be per- to a high degree of efficiency. For up to 500 H.P. (at rail) hydraulic nissions are accepted by this Rail- out for higher power electric trans- n is preferred. There is now very difference between power and t of either of these types. The low ncy of the hydraulic type is offset e simplicity of maintenance, but here in the higher powered loco- es, electric transmission is now simple. This railway recently took ry of some G.M. locomotives of 78 tons weight but of 1 450 H.P. lectric transmission is very simple nly a forward and reverse control.	We consider that the various methods of transmission should be applied to the following units of power :— Up to 150 H.P. — Mechanical. 150 to 600 H.P. — Hydraulic or hydro-mechanical. Over 600 H.P. — Electrical. Mechanical transmission gives high efficiency at a specified output but rapidly falls away at other output. Both hydraulic and hydro-mechanical do not give a very high efficiency at an output other than specified. Electrical transmission unlike the above systems is able to transmit the power at almost constant efficiency throughout the speed range.	In the United States the electric transmission has been universally used. It is efficient and requires minimum maintenance. Also, the simplicity of multiple axle drives dictates the use of the electric transmission for very small switching locomotives. There is the possibility that a hydraulic drive might have some advantage, however, hydraulic drives have been used only in experimental locomotives in this country.
will depend largely on the cir- ances. For narrow gauge locomo- jackshaft drive from a gear box eferred, but on broad gauge we cardan shaft drive. Chain drives ot suitable.	Axle drive incorporating a propeller shaft with universal joints combined with a set of bevel wheels. Combination of jackshafts and coupling rods for small shunting engines.	Have had too limited experience with Mechanical or Hydraulic transmissions to furnish any information on this question.
rred for electric transmission as s simpler for general maintenance.	If equipped with two or more traction motors, permanent parallel or permanent series. Very little difference in the choice between the two except that in the case of driving wheel slip the permanent parallel is superior to permanent series in recovery. Do not consider mechanical connection between the axles of locomotives fitted with electrical power transmission is required.	We favour electrical connection of traction motors and do not use mechanical connections between axles.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
METHOD OF TRANSMISSION		
20. *In the light of your experience and in all investigations made by your administration, what, in your opinion, are the respective fields of use for the various methods of transmission, mechanical, hydro-mechanical, hydraulic and electric ?* *What are their advantages and disadvantages ?*	The straight diesel mechanical type is suitable for light railcar operation and small shunting locomotives. The Voith system has been applied to our diesel locomotives from 300 H.P. to 888 H.P. Although the maximum size in use will be 888 H.P. its reliability and freedom from trouble with other users lead us to believe that 888 H.P. will be well within its range. In order that the full benefit of maximum horse-power may be utilised, and no drop in engine r.p.m. be experienced when gear changing, the Voith transmission has been installed on all the latest designs. In addition to its relatively stepless power output the Voith transmission appears to be sufficiently rugged to withstand the harsh treatment given by African staff in the course of training. Furthermore, this type of transmission is within the scope of our present maintenance staff.	Not applicable.
21. *In the case of mechanical, hydro-mechanical or hydraulic transmission, what system of axle drive do you favour in the light of your experience ?*	All locomotives in use and on order have a jackshaft driving the wheels through side rods, the jackshaft being driven by the gearbox through a spiral bevel gear.	Not applicable.
22. *In the case of electric transmission, what arrangements do you advocate to obtain the best adhesion coefficient, from the point of view of :* (a) *electrical connection of the traction motors if the locomotive has independent axles ?* (b) *mechanical connection between the axles in the alternative case ?*	—	This is more a question for Design Engineers to answer.

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
hydro-mechanical transmission systems not yet reached a state of develop- necessary for railway service. Mechan- transmission is considered suitable for r powers, perhaps up to 300 H.P. For r locomotives, we consider the electric mision as well as the hydraulic trans- on as fully serviceable. The electric mission must perhaps today be consid- more reliable and above all more tried the hydraulic one. Electric transmis- makes the locomotive heavier than aulic transmission, which means that ratio power weight will be somewhat l. It is therefore considered that, cularly for train haulage locomotives, ill be necessary for us to choose the aulic transmission in order to obtain cient high powers at a reasonable ht. The hydraulic transmission will be cheaper in initial cost than the ric transmission. Both systems are king satisfactorily for train haulage.	No experience in normal working. Have only electric working. Voith Hydraulic and Maybach Mekydro transmission on order.	—
nting locomotives Di 2 (1 B.B.1). tly transmission to a blind axle by l gears, where also the driving direc- can be altered, then from the blind axle ne driving axle by connecting rods. train hauling locomotives, cardan shaft all axles in each bogie coupled is idered the most appropriate transmis-	Cardan shaft for the 400 H.P. and chain for 135 H.P.	—
shunting locomotives, where the run- qualities are of less importance, trans- ion by connection rods is considered for reasons of adhesion. train hauling prefer bogie locomotives individual drive respectively with bled cardan shaft transmission.	Electrical connection.	—
	Not fitted.	

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAYS*
23. *Do you consider it possible with all types of transmission, given a good state of wear and maintenance cost, to make continuous use of the total power produced by the diesel motor for a very extensive range of locomotive speeds?*	So far as transmissions other than electrical are concerned, the answer would appear to be "Yes", but this will require to be confirmed by actual experience.	Within the limits of capacity of the various forms of transmission all types can utilise full engine power over long periods. The hydraulic type however requires the provision of generous heat exchanger capacity to enable it to do this and for high torque conversion ratios dissipates nearly half the engine power as heat instead of delivering it to the driving wheels. The chief factors influencing the choice of transmission to be adopted are— (1) Power to be transmitted; (2) Reliability; (3) Cost.
DEPARTMENTAL ORGANISATION AND OPERATION		
24. *For which types of locomotives and for what services is driving performed by one or two employees (or more)?*	At present main line diesels are manned by two men. One man only is required for shunting.	As a result of Union pressure we have been forced to carry two men on all main-line diesel electrics. For locomotives working in multiple no additional staff are carried. One man operates diesel shunters or where visibility is bad in busy yards two men are employed. Diesel shunters, while engaged in transfer duties to neighbouring stations, carry two men.
Does the second member of the crew have any other duties than those of assisting the driver?	The second man on main-line diesel locomotives attends to the steam heating boiler and checks lubricating oil pressure, water pump in engine room and reports anything unusual to the driver; he also observes signals.	There is little the second man can do but to identify signals, inspect engine at regular intervals and undertake fireman's duties at crossing stations, tablet exchange, etc.
25. *To which department (Motive Power or Operating) do the driving staff belong?*	The driving staff belong to the Motive Power Department.	All diesel mechanical shunters over 200 H.P. are manned by locomotive running (Motive Power) personnel, so also are all diesel electric locomotives. Shunters under 200 H.P. are operated by Traffic Branch members. However, in selected localities defective vision engine drivers are used in their place. Certain conditions have to be observed by the latter to ensure that there is no danger of signals being missed. These arrangements were made following negotiations with the engine drivers' Union.
26. *How are Diesel locomotive drivers recruited?*	Diesel locomotive drivers are recruited from steam drivers and firemen who have been passed for driving.	Selected from first grade engine drivers on steam or electric locomotives.
27. *Have you established training schools for forming a basic driving and maintenance staff? What are the characteristics of these schools?*	A training scheme has been established where supervisory and maintenance staff and drivers are taught the general working of diesel engines, transmission, maintenance and driving technique.	We have no formal training shool. Technical and practical tuition is given by specially appointed instructors.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
The locomotives on this Railway signed for continuous operation at ower above 12 m.p.h.	No.	No.
oth shunting and train haulage otives a driver and assistant are led.	Regardless of the type of locomotive and service worked, our driver is always accompanied by an assistant.	All services employ one driver.
ther duties than that of assisting .	Yes, in addition to assisting the driver, this man is responsible for keeping a look-out and picking up and delivery of the tablet on single line track. Such an arrangement as this is not so much because of the economical consideration but for the sake of safety.	Second men vary with different railroads. Watches for signals, watches temperatures and where air intakes are manually operated makes necessary adjustment, makes periodic trips into engine compartment to observe engine operation, gives assistance to the driver when required.
riving staff belong to the Motive r Department.	Operating Department except on a small "shunter" of less than 10 tons weight which is confined to station compound and manned by station staff.	Driving staff usually are under the control of the Motive Power Department except when engaged in hauling trains or performing switching operations at which times they are under the control of the Operating Department.
r steam locomotive drivers subnt to a course of training on diesels lso from diesel driver apprentices ited directly for training. A course of three years in the of drivers and five years in the of the maintenance staff. The e covers both the theoretical and ical aspects. The drivers are specirained in fault tracing on the locoes.	Recruited from among the steam or electric locomotive crews and they are trained for a certain period. No.	Promoted from the ranks of fireman or the second man on the locomotive. No. However, some of the locomotive builders as well as some of the railroads hold instruction classes on phases of locomotive maintenance. Most of the driver instruction is performed on the job.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
23. *Do you consider it possible with all types of transmission, given a good state of wear and maintenance cost, to make continuous use of the total power produced by the diesel motor for a very extensive range of locomotive speeds?*	With shunting services and short transfer trips the locomotives are not kept at full load for long periods though they are in some instances used intermittently at full load for a number of hours. The fluid drive/mechanical system on the 200 H.P. locomotives in service does not overheat under these conditions at the coastal ports (Ambient temp. 90° F humidity 90 % unless the locomotive is overloaded).	—
DEPARTMENTAL ORGANISATION AND OPERATION		
24. *For which types of locomotives and for what services is driving performed by one or two employees (or more)? Does the second member of the crew have any other duties than those of assisting the driver?*	We have, on diesel locomotives, restricted footplate staff to one driver excepting those locomotives required to work in the Main Works where it is considered a fireman is required to keep additional watch in the confined spaces inside the Works.	On the only type of locomotive operated at present on the Nigerian Railways, a driver and fireman are always employed. The fireman's only duties consist of assisting the driver.
25. *To which department (Motive Power or Operating) do the driving staff belong?*	The Motive Power Section of the Chief Mechanical Engineer's Department.	All drivers belong to Operating and Commercial Department — there being no Motive Power Department on Nigerian Railways.
26. *How are diesel locomotive drivers recruited?*	It was found, with the friction clutch-manual gearbox transmission system, that African drivers did not adapt themselves too well to the technique required, consequently wear and tear of transmission components was considerable. Some locomotive drivers were therefore recruited from road vehicle, and other internal combustion engined machines. With the conversion to fluid/power gearbox and the delivering of the new Voith type transmission locomotives, we have reverted to normal recruitment from the steam locomotive footplate staff.	Drivers are recruited from the present Grade I drivers operating steam locomotives and are selected according to their abilities.
27. *Have you established training schools for forming a basic driving and maintenance staff? What are the characteristics of these schools?*	We have established schools for training steam locomotive footplate staff, and shunters from this grade were taught the general principles of driving diesel locomotives in order to provide the staff for the original locomotives. It has not been found necessary to date to have a separate instructional course for diesel locomotive footplate or maintenance staff, though this matter will have to be given attention if and when main-line diesels are introduced.	No training schools as such have been established for the present comparatively small numbers of locomotives. Classes of not more than three drivers receive instruction from the Locomotive Inspectors — the course being of 2-3 weeks duration. At the end of the course an oral examination is given to the drivers on which a pass mark of 80 % or more has to be obtained. A number of maintenance staff have been trained at Contractors Works in U.K. but it is hoped that future recruits will be trained locally.

NORWAY	REPUBLIC OF IRELAND	NEW SOUTH WALES
with electric transmission as well as hydraulic transmission.	Yes.	—
enerally based on one man service.	One man operation intended.	—
ing tractors (diesel locomotives up to 180 H.P.) are allowed to be driven e staff of the stations within the range e station. Elsewhere, only locomotive rs are employed.	Motive Power.	—
drivers of steam locomotives or ic locomotives after special training.	From existing staff.	—
has a special school (6 months) for notive crew. In addition, the diesel notive drivers are given special train- The staff for maintenance gets special ng.	Yes,	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
28. *Where depots only perform day-to-day maintenance and does not permit of maintenance staff being diverted to driving duties, how do you maintain, or how do you propose maintaining the driving of locomotives during the time that regular services are supplemented by peak services?*	Drivers and maintenance men are in different categories and maintenance staff are not used for driving. A limited number of drivers are allocated at Motive Power Depots to cover illness and special working.	This practice has never been adopted or consid ered on the New Zealand Railways.
29. *In order to ensure the best use of the staff, does your organisation make provision for drivers to be authorised to drive all the different kinds of diesel locomotives (also if applicable, electric locomotives when the system is partly electrified)?*	Yes.	Yes. All engine drivers are competent to driv steam locomotives. Wellington is a largely elec trified depot and has a substantial number o diesel electrics and railcars also. All drivers a this depot can drive one or more of these types i addition to steam.
30. *Does the driving staff of diesel locomotives perform their duties over the whole system or are they allocated to certain routes? If over the whole system, are the staff allowed to drive all the various types of diesel locomotives?*	Drivers carry out their duties over sections of the line of which they have knowledge of signals, speed restrictions and gradients. This could involve driving all types of diesel locomotives.	A driver is permitted to work trains over any roa of which he has the required knowledge. Engin drivers have "home" depots and "lodging turns on this Railway are few, consequently, it is un common for an engine driver to work over trac more than 100 miles from his "home" depot. Th exceptions are chiefly on railcar runs between main centre and a provincial town and are up t 250 miles, after which the engine driver is "booke off" before taking up his return run.
31. *By what staff is the diesel locomotive serviced before departure? What are the duties laid down for this servicing?*	The maintenance and servicing staff service the locomotives before departure. The duties laid down include refuelling, checking oil and water levels, checking for loose or defective parts on the power equipment and locomotive.	This is done by the Depot maintenance staff. includes all work necessary to enable the locomo tive to go into traffic and covers such items a taking sand, fuel, cooling water etc., which in th case of steam power is done by the engine crew (at larger Depots by special crews).

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
ger number of drivers than those ly required for the normal service vailable.	Reserve crews available, or temporary help from other depots can be obtained.	Drivers and maintenance men are separate organisations. Extra enginemen are maintained at terminals to be used as needed both for extra work or in case of illness of regular enginemen.
subject to a course of training on class of locomotive.	We have no provision for drivers who are authorised to drive one type of locomotive to drive another type of diesel unit.	Yes.
are allocated to various divisions re transferable and work in other ons after learning the roads.	Diesels not operated over the whole system. However, the drivers perform their duties over the whole system which is dieselised.	Driving staff is assigned to districts.
e maintenance staff. They follow intenance schedule drawn up for class of locomotive in addition to ing which may warrant special ion as booked by driving staff.	An Inspector and a fuel-water tender take care of the locomotive before driving staff take charge of it. The Inspector inspects the designated parts and supplies the lubricating oils. The fuel-water tender supplies the fuel oil. The regular driving staff join in the inspection, especially for the main parts of the locomotive.	Maintenance staff inspect running gear and engine operation, test brakes and other safety appliances, inspect supply of fuel, lubricating oil, water and sand.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
28. *Where depots only perform day-to-day maintenance and does not permit of maintenance staff being diverted to driving duties, how do you maintain, or how do you propose maintaining the driving of locomotives during the time that regular services are supplemented by peak services ?*	The duties to which our diesel locomotives are allocated are not seasonal, and do not fluctuate to a degree where the normal pool of drivers cannot meet demand.	Not applicable.
29. *In order to ensure the best use of the staff, does your organisation make provision for drivers to be authorised to drive all the different kinds of diesel locomotives (also if applicable, electric locomotives when the system is partly electrified) ?*	As all diesel locomotives are on shunting duties, and the characteristics of the diesel locomotives in service at the moment are similar, drivers are considered competent to work all types at the depot at which they are stationed.	Only one type of Diesel locomtive at pr sent in operation.
30. *Does the driving staff of diesel locomotives perform their duties over the whole system or are they allocated to certain routes ? If over the whole system, are the staff allowed to drive all the various types of diesel locomotives ?*	Yes.	Only one section, i.e. Zaria-Kano is present being dieselised and all drivers ar based at Zaria depot.
31. *By what staff is the diesel locomotive serviced before departure ? What are the duties laid down for this servicing ?*	The locomotives are maintained and serviced by the fitting staff at their home depot, this includes the preparation of the engine and locomotive prior to acceptance by the driver taking it into traffic. The normal daily routine includes the filling of all grease cups and nipples, topping up where necessary oil boxes, engine sump gearbox, compressor sump and fuel oil tank, checking and filling when necessary the radiator water level. All controls and gauges are checked and adjustments made as required.	All locomotives are examined by Dies Shed Maintenance Staff on arrival at depo their duties being as follows :— (1) Refuel. (2) Top Up engine sump lubricating oil required. (3) Top Up engine cooling water system required. (4) Examine engine for leaking joints, pipe etc. (5) Top Up super-charger bearings required. (6) Generally examine wheels and unde frame. (7) Examine all lights. (8) Examine all spare fuses. (9) Rewind Hassler recorder and remov chart for previous run. (10) Attend to defects reported by drive Before a locomotive departs from dep the driver carries out the following examin nation :— (1) Check fuel oil. (2) Check lubricating oil (engine and supe chargers). (3) Check engine cooling water. (4) Run up engine and check for leaki joints, pipes, etc.

NORWAY	REPUBLIC OF IRELAND	NEW SOUTH WALES
suspension of freight trains and by ge of the service of the locomotive .	By training Traffic Staff.	—
but is considered an advantage that the is kept as much as possible to the kind of traction stock.	Yes.	—
driving staff of diesel locomotives are ed to drive the different types.	Over the whole system. Yes.	—
maintenance staff prepare the loco- ve, except that the locomotive is tested ie driver before starting out. The time ed is different for the different types comotives.	Chief Mechanical Enginer's Staff.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
32. *In the case of low power locomotives being in service in isolated districts situated some distance from the home depot and which perform shunting and short distance runs on low density traffic lines, and where driving duties are performed by staff of the stations in that area, how do you organise :*	This does not apply. All trains are worked by Motive Power staff.	The terms of this question apply in our case to diesel mechanical shunters stationed at smaller provincial centres.
(a) *driving instruction ?*	Considerable thought has been given to driving instructions for all types of diesel locomotives and these have been issued to drivers.	Driving instruction, inspection and current maintenance is done by tradesmen who travel out to where the diesels are located. Small repair jobs are often done by local motor firms.
(b) *technical supervision of staff in the performance of driving duties ?*		The only day-to-day supervision of the driver in the execution of his duties is by the station master. We find that, once properly trained, most traffic members who drive these units do not require much supervision.
(c) *inspection and current maintenance of locomotives ?*	The inspection and current maintenance is carried out at main depots where periodical and mileage examinations are done to all types of locomotives.	
33. *Has dieselisation enabled you to modify to any extent the method of operation over certain lines ?*	Yes. On certain sections of the line, steam locomotives have been replaced by diesel lightweight trains. The introduction of diesel lightweight trains working intercity trains has provided accelerated services — this also allows for a quicker turnround.	An endeavour is being made to exploit the ability of the diesel to make long runs without engine changes and stops for water by building up "through" goods trains between Wellington and Auckland, a distance of 426 miles. The scheme is not working perfectly yet but the greatly improved wagon turn-round and faster delivery of ordinary freight have justified the trial. Main-line diesel operation in this country is still in its early stages and there is not much that we can contribute on this subject.
35. *In what way do you think reserves of diesel locomotives should be provided to cover such matters as traffic peaks, diversions or emergencies ?* *What is the normal use of corresponding engines ?*	The provision of extra diesels to cover peak periods cannot at present be truly stated.	This is not likely for several years as we have a reserve of steam power. If at some low utilisation rate the steam locomotive is cheaper then sufficient reserve should be kept to cover such needs.
37. *What changes have occurred, in relation to the previous method of traction, so far as concerns distance run and hours in use ?*	Unable to answer this question in detail but it has been established that approximately 50 % more work can be done by diesel shunting locomotives compared with steam shunting locomotives per 24 hours.	The average distances per annum is as follows :— steam locomotives . . . . . 71 000 Km diesel electric locomotives . . 93 700 Km
— *the availability of shunting compared with total stock (including those available and those out of service).*	Availability of diesel shunting locomotives 91.0 %. Availability of steam shunting locomotives 90.0 %.	The information for diesel shunters is not available.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
	Not in a position to answer this question.	
ers used to the type of locomotives district are posted to the division.	—	Travelling instructors.
rvision is in the hands of diesel ed foremen.	—	Travelling instructors.
oremen and maintenance staff train- n these locomotives and posted to ivision. Daily service schedules are eration to ensure maximum periods een visits from depot to workshops. system has been applied to shunting notives.	—	Locomotive sent to a terminal where facilities are available for the necessary maintenance or personnel sent to the location where the locomotive is assigned to perform the necessary maintenance.
Yes.	Yes, to a certain extent, but we have not reached a definite conclusion, although in fact under the existing facilities the number of locomotives has been reduced compared with steam locomotives.	Yes.
er units in excess of normal require- s are made available for working al trains.	Unable to answer this question as there are only three locomotives on train haulage use.	Traffic peaks usually do not develop at all points of a railroad at the same time, therefore, locomotives can be shifted from one district to another to meet traffic requirements.
—	Not in a position to give details.	Figures for exact utilisation of locomotives are not available.
		The diesel locomotive has much more availability than the steam locomotive because of less service and shopping for boiler attention in this type of power.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
32. *In the case of low power locomotives being in service in isolated districts situated some distance from the home depot and which perform shunting and short distance runs on low density traffic lines, and where driving duties are performed by staff of the stations in that area, how do you organise :*	Where a locomotive is stationed away from its home depot, at an isolated yard, etc., the driver posted there is one considered competent to carry out the daily maintenance routine and detect engine faults in sufficient time to allow the locomotive to be replaced. Arrangements are made for the locomotive to be inspected a regular intervals at its home depot.	Not applicable.
(a) *driving instruction ?*	The driver is a fully trained individual from the Motive Power Section and he is the only person at the station authorised to drive the locomotive.	
(b) *technical supervision of staff in the performance of driving duties ?*	Out-station footplate staff are regularly supervised and instructed by the Locomotive Inspectors and Loco. Foreman in charge of the driving staffs home depot.	
(c) *inspection and current maintenance of locomotives ?*		
33. *Has dieselisation enabled you to modify to any extent the method of operation over certain lines ?*	—	Dieselisation not yet complete so unable to give full answer.
35. *In what way do you think reserves of diesel locomotives should be provided to cover such matters as traffic peaks, diversions or emergencies ?* *What is the normal use of corresponding engines ?*	The diesel locomotives are used in conjunction with steam shunting locomotives at the moment, and the two types are to some degree pooled to provide the necessary power to cover Operating demands.	With the small number of locomotives at present in use it has been found advantageous to keep one locomotive spare to cover emergencies and any additional power which may be required for an additional train.
37. *What changes have occurred, in relation to the previous method of traction, so far as concerns distance run and hours in use ?* — *the availability of shunting compared with total stock (including those available and those out of service).*	The availability of shunting locomotives, i.e. all our diesel locomotive stock is as follows : — Kenya/Uganda Lines . . . . 77.53 % Tanganyika Central Line . . . 70.77 % Tanganyika Southern Province Line . . . . . 67.79 % All Sections . . . 70.89 %	Diesel locomotives have not yet been in service for a sufficient length of time to enable this question to be answered fully.

NORWAY	REPUBLIC OF IRELAND	NEW SOUTH WALES
	Not yet defined.	—
The training is organised in courses.		
e technical supervision is performed by pecially trained controller in each district.		
He also supervises the maintenance.		
selisation is not yet accomplished on of the NSB lines. It is, however, sidered possible to better the service of railways by the use of diesels.	Yes.	—
ffic peaks within passenger traffic is led by suspension of freight trains or reserve locomotives which are also used diversions and for snow clearing ser-e.	Not yet determined.	—
now, diesel locomotives have been set tours which are giving a specially ourable result, as a diesel locomotive is lacing 3 or 4 steam locomotives. érage kilometric distance 800 km a day. erage number of daily hours about 15.	Not yet known.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAYS*
38. *Where you have had occasion completely to substitute diesel for steam traction in a large shunting yard, what was the required number of steam locomotives, what is the number of diesel locomotives with which you have been able to maintain the same service and what is the total number of shunting hours before and after dieselisation (these locomotive statistics should be shown both to include and to exclude locomotives out of service)?* *How have staff statistics (salaried and wages grades) altered?*	(1) Number of steam locomotives (including spares) required : *Booked* 14 *Spares* 4 *Total* 18 (2) Number of diesel locomotives now employed (including spares) : *Booked* 10 *Spares* 2 *Total* 12 *Hours per week* (3) Total number of shunting (a) before dieselisation . 1 850 (b) after dieselisation . 1 515 (4) Alterations in :— (a) Salaried Grades — Nil (b) Wages Grades — 34 Firemen Since the time when steam engines were booked to perform all the shunting at Toton there have been considerable changes in the work at Toton Sidings due to the modernisation of this marshalling yard. The reduction in the shunting hours per week cannot be said to be entirely due to dieselisation.	In no large shunting yard has the diesel yet completely replaced steam, therefore, the information sought cannot be supplied so far as this Railway is concerned.
MAINTENANCE		
39. *What factor do you take as a basis for determining the frequency of inspections and periodic overhauls of diesel locomotives? Is the basis of examination carried out on mileage, number of running hours, number of operating days, etc.?*	In the normal way, examinations are carried out on a daily and mileage basis, excepting a 10-15 day examination necessary on diesel shunting locomotives.	Apart from certain routine daily and weekly inspections, main-line diesels electric are scheduled for prescribed work on completion of net mileages. For diesel shunters inspections are based on working hours accumulated.
State the reasons for your preference.	It is preferable to relate the examination to the type of engine, i.e. say, for a high speed engine the mileage examination would be carried out at a lower mileage than for a slow running engine.	In the case of the main-line stock, attention required is closely related to the mileage run and choice of this as a basis logically follows. In addition, it is easier to keep mileage figures up-to-date and to "budget" ahead on this basis than any other. The fact that reliable mileage data is not readily available for shunters necessitates adopting working hours as the basis. In time we hope to be able to use the spectrographic examination of oil as a means of determining when anything is amiss with the diesel engine.
40. *What is the type and frequency of inspections and periodic overhauls that you have adopted?*	Examination schedules attached (A).	Schedule attached (B).

CEYLON GOVERNMENT RAILWAYS	JAPAN	U.S.A. ASSOCIATION OF AMERICAN RAILROADS
ing yards have not been completely ised on this Railway yet.	No shunting yard completely dieselised.	No complete figures available because of changing traffic conditions and operating changes.
		Salary and wage grades have been affected only slightly by the use of diesel power.
d on engine hours for power units mileage for the running gear; locoe manufacturers' recommendations till being followed but these will be d in the light of experience gained e course.	Examinations carried out on a kilometre basis, because the amount of work done by a locomotive, we consider, will be best indicated by the number of kilometres run. We consider it preferable to relate these examinations to the characteristics of the engine.	Some railroads use mileage and some service hours as the basis for overhauls.
		No preference, but consider that spectographic examination and analysis of oil would be useful as a guide to indicate the condition of the engine.
e vary with the different types of notives, some of which have been duced only very recently. Standards be laid down in the near future.	Not yet established any definite rules and regulations for these inspections; applying tentatively the regulations for electric locomotives, simple inspections, such as trip inspection, monthly inspection, etc.	The United States Government requires inspections of locomotives at monthly, 3 months, 6 months, annual and five year periods.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
38. *Where you have had occasion completely to substitute diesel for steam traction in a large shunting yard, what was the required number of steam locomotives, what is the number of diesel locomotives with which you have been able to maintain the same service and what is the total number of shunting hours before and after dieselisation (these locomotive statistics should be shown both to include and to exclude locomotives out of service)?* *How have staff statistics (salaried and wages grades) altered?*	Steam shunting power has not been completely substituted by diesel power in any yard, although it has been the policy to make all recent additions to our total shunting power in the form of diesel locomotives. There has been no clear demarcation in the changeover to diesel power, and as various other improvements which have been made to yards, storage facilities, etc. during their time in use add to the complications, it is not possible to give reliable figures of any saving.	No shunting yards have yet been dieselis on Nigerian Railways.
MAINTENANCE		
39. *What factor do you take as a basis for determining the frequency of inspections and periodic overhauls of diesel locomotives? Is the basis of examination carried out on mileage, number of running hours, number of operating days, etc.?* *State the reasons for your preference.*	Overhauls have been arranged on a time basis i.e. operating days. This method was adopted due to the unreliability of mileage recorder mechanisms, and it allows better planning of the examination programme. The time based examinations include oil changes though these are co-related to engine condition and made more frequently if engine condition warrants it.	Frequency of maintenance is at present function of locomotive mileage — the mil age being an easier figure to arrive at fro the mileage recorders fitted to the loc motive. It is considered preferable to relate t diesel engine maintenance to the engi characteristics as determined by oil analys (Quantitine or Spectrographic) and oil co sumption figures particularly for maj overhauls.
40. *What is the type and frequency of inspections and periodic overhauls that you have adopted?*	—	The present frequency of inspections is follows :— (a) 1 800 miles (b) 9 000 miles } Running Shed Inspectio (c) 27 000 miles (d) Intermediate Overhaul i.e. tyre turni and top overhaul of engine at 72 000 mil (e) General Overhaul at 270 000 miles.

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
ıave had no such occasion.	Not yet known.	—
shunting locomotives, number of daily s. which are giving the best results. train hauling locomotives, mileage.	Mileage.	—
shunting locomotives Di 2 : 1 10 days, inspection in the depot. 1 month (500 hours of service) monthly ection (inspection for the whole loco-ve). 1 4 months (2 000 hours of service) repair (inspection of motor and trans-ion). r 3 years (18 000 hours of service) ral repair. eral repair of the locomotive with turn-of wheels. eral repair of motor (exchange of or).	(Daily or 300 miles. Weekly or 2 000 miles. Monthly or 8 000 miles. 3-monthly or 25 000 miles) at Motive Power Depots. (6-monthly or 50 000 miles. Annually or 100 000 miles. General overhaul — every 3 years or when necessary) in Workshops. Schedule attached (C.).	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
42. *Do you consider it advisable to re-profile wheel tyres while the axles remain in place on the locomotive ?* *If so, what machinery do you use (or do you suggest should be used) ?*	Yes. The "Tyre Profile Truing Machine" of the Equipment Manufacturing Co., Chicago, is being considered. No actual experience yet.	No experience. This is a practice that has obviou attractions and, with the continued drive for bette locomotive availability, seems likely to make head way in the future. —
43. *From the point of view of ensuring that operating costs be as low as possible, do you consider it advisable to carry out maintenance operations to extend to the maximum the periods between attention to each of the various parts ?*	Carry out all examinations before the material is actually fatigued as shown in Schedule under item 40. Typical figure for periodic overhauls and running maintenance of diesel shunting locomotives is 74 man hours per 1 000 kilometres.	Because of a serious shortage of competent trades men it is the practice to inspect only those parts which on past experience, may possibly require early attention. Such parts are then ignored when the locomotives are subsequently in the Depot until due for a further examination. We have thus stretched the principle of "Preventive" inspection about as far as possible the aim being not to reduce operating costs but to make the best use of the available manpower. Given a more adequate skilled force a more frequent inspection would be made of components as this would uncover incipient failures at an earlier stage. It is intended to extend the period between inspections, if such is warranted, as experience is gained.
What is the number of man hours per 1 000 kilometres to the various types of work on each of the principal types of locomotive ?	We have not yet sufficient experience regarding other types of locomotives.	—
45. *For engine cooling, do you use :* *— plain water or water that has been treated, i.e. anti-freeze ?* *— pure distilled water ?*	Treated water which is normally in use for the steam locomotives is used for diesel engines.	Plain tap or rain water is used. Chromate inhibitor is added plus anti-freeze in localities subject to cold winters.
— water to which a chemical has been added to avoid corrosion of the water jackets ?	No chemical issued to avoid corrosion.	Soda ash and caustic soda added where the raw water has low pH values : Scale has not proved a problem to date and our main objective has been to check corrosion. Temporary hardness predominates in New Zealand.
46. *What are the average percentages out of service due to :* *— inspections,* *— overhauls and* *— accidental causes*	Average percentage 9 %. 5 %. 4 %.	None of our main-line diesels will be due for overhaul for a long time yet. Trustworthy percentages cannot be given at this stage.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
Yes.	Yes, if the necessity arises at a period long before it is time to send the locomotive to the shops for a general repair.	Yes.
proposed to order the type of ne very largely in use in America.	No special machinery for the purpose has yet been installed nor are we able to suggest anything definite in this direction.	Wheel truing machine (commercially available).
Yes.	Yes.	Yes.
Figures are not available.	Man-hour data not available.	No record.
ed water is used on some locoes.	We use water drawn from underground.	—
Pure distilled water.		—
	A magnesium rod called "Galvo rod" is inserted in to the water jackets to avoid possible corrosion to the jackets.	A chemical added with the object of avoiding corrosion to the jackets of the diesel units.
oximately 20 %. (Exact figures vorked out.)	Definite figures not available.	No information available. Varies between types of inspection and types of make of locomotive.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
42. *Do you consider it advisable to re-profile wheel tyres while the axles remain in place on the locomotive ?*	The wheel tyres on the shunting locomotives are profiled when necessary on the shed wheel lathes.	No tyre re-profiling is at present carrie out on locomotives operating on Nigeria Railways, nor is this procedure contempla ed. It is thought that this method woul only prove economic on larger diesel loc motives where there is a large amount work involved in lifting and removin axles for normal tyre turning.
If so, what machinery do you use (or do you suggest should be used) ?	It is not considered necessary with our present small fleet to equip depots with in-situ wheel turning equipment.	—
43. *From the point of view of ensuring that operating costs be as low as possible, do you consider it advisable to carry out maintenance operations to extend to the maximum the periods between attention to each of the various parts ?*	With African drivers it has been found undesirable to extend the period between examinations for too long as it cannot be expected that their perception and analysis of defects is of a sufficiently high order to avoid major damage, if frequent checks are made.	It is definitely considered that maintenanc periods on various items of locomotiv equipment should be extended as far a possible.
What is the number of man hours per 1 000 kilometres to the various types of work on each of the principal types of locomotive ?	No statistics are available.	Average man hours per 1 000 locomotiv miles are given below for various items o power equipment :— Air Filters — 8 man hours/1 000 mile Traction Motors — 5 man hours/1 000 mile Control Frame — 5 man hours/1 000 mile Diesel Engine (including oil filters) — 8 man hours/1 000 mile
45. *For engine cooling, do you use :*		
— plain water or water that has been treated, i.e. anti-freeze ?	Plain water.	
— pure distilled water ?	—	At present pure distilled water is being use for engine cooling.
— water to which a chemical has been added to avoid corrosion of the water jackets ?	—	A demineralising plant will be installed fo treating mains water for engine coolin purposes.
46. *What are the average percentages out of service due to :* *— inspections,* *— overhauls and* *— accidental causes*	Statistics are not available to enable the breakdown to be given. The total out of service figure including Works repairs is 29.11 %.	(a) During the month of March 1955, th average daily number of locomotives ou of service due to inspections was 0.9, bu this figure included one locomotive under going "drying out" after being delivere new from U.K. (b) Not yet applicable. (c) Not yet applicable.

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
No.	Preferable if number of units justifies capital investment.	—
—	—	—
Yes.	Yes.	—
ber of man-hours for inspection and tenance for Di 2 : 50 hours per 1 000 of shunting service (4 km per shun-nour).	Not yet available.	—
minary plain water, in the future with ldditive.	Treated water.	—
—	—	—
—	—	—
nave too little experience to answer.	Not yet available.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWA*
47. *Even though it may not be general practice, are there any instances where temporary traffic requirements lead to the replacement of railcars or sets hauled by light railcar units by a heavy set hauled by a diesel locomotive?*	No.	No.
What stock do you consider should be used in such a case: light rolling stock or vehicles previously used in passenger services?	No.	35 articulated railcars have been ordered and th first are on the point of going into revenue traffi These units have axleloads of only $10\frac{3}{4}$ tons an so possess almost universal running rights ove this Railway.
Alternatively, do you consider it more economic to intensify the service with railcar units?	Yes.	From the staff angle there will be an economy in the use of engine drivers if one man operatio is adopted as probably will be the case. For thes reasons the more intensive use of railcars i preferred to diesel worked car stock.
What provision do you make to have the required number of such units available?	Covered by spare unit or units which are available in areas to cover shopping and heavy maintenance repairs.	—
48. *If the use of locomotives is never anticipated for passenger services, what is to be done with the heavy rolling stock previously steam hauled?*	Heavy rolling stock previously hauled by steam, is, and will be in increasing numbers, hauled by diesel or electric locomotives. Where diesel rail cars replace steam hauled stock and this stock is not life expired, it will be absorbed in other services which may be steam or diesel or electric locomotive hauled.	As none of our diesel electrics are fitted wit steam heat boilers, express passenger services wi continue to be worked by steam locomotive, there fore, the question of disposal of heavy car stoc does not arise.
Finally, what appears to you to be the most economic solution to this problem if the system is dieselised?		
49. *In the instance cited under question 32, where a district is using a certain number of these locomotives, do you consider it would be useful to organise road motor emergency breakdown service suitably equipped and manned by qualified technical staff?*	Yes, in the instances of multiple unit diesel trains and diesel shunting locomotives.	Has not been considered and is not necessary o this Railway. Minor repairs are undertaken b local motor firms and there is little difficulty i making arrangements for competent staff to trave to the disabled shunter when required.
Do you think that economies would result in this way by avoiding journeys between station and repair workshop?		

CEYLON GOVERNMENT RAILWAYS	JAPAN	U.S.A. ASSOCIATION OF AMERICAN RAILROADS
rail cars are not available, trains o be worked using existing rolling suitable for the particular traffic.	Not in a position to reply.	Yes.
—		Previous passenger equipment if available.
—		No.
—		Survey of past peak requirements. Special transportation requirements are usually known in advance and equipment can be provided to cover such requirements.
ng steam hauled rolling stock will ue to be used with the introduction sels.	In both cases cited in this question, the heavy rolling stock previously steam hauled were to be allocated to other sections where more passenger coaches are demanded.	Scrap the old equipment if unable to utilise at other locations. If the potential traffic volume warrants, purchase modern light weight equipment.
notives have not been allocated to ons yet and as the distances are o great the necessity will not arise.	Unable to answer this question.	Yes.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
47. *Even though it may not be general practice, are there any instances where temporary traffic requirements lead to the replacement of railcars or sets hauled by light railcar units by a heavy set hauled by a diesel locomotive ?*	We replaced light diesel rail cars on one branch line by normal steam operated locomotives; a heavier diesel locomotive could have taken over these duties if available. As suitable steam locomotives are available the question does not arise.	Not applicable.
What stock do you consider should be used in such a case : light rolling stock or vehicles previously used in passenger services ?	—	Not applicable.
Alternatively, do you consider it more economic to intensify the service with railcar units ?	Rail cars are useful in exploring the possibilities of passenger traffic on branch lines, and they can be used to build-up passenger traffic from a level uneconomical for heavier train operation.	—
What provision do you make to have the required number of such units available ?	—	—
48. *If the use of locomotives is never anticipated for passenger services, what is to be done with the heavy rolling stock previously steam hauled ?*	The new East African Railways and Harbours stock is of light aluminium construction and it will be suitable for attachment to any form of motive power at a future date.	Not applicable.
Finally, what appears to you to be the most economic solution to this problem if the system is dieselised ?		
49. *In the instance cited under question 32, where a district is using a certain number of these locomotives, do you consider it would be useful to organise road motor emergency breakdown service suitably equipped and manned by qualified technical staff ?*	We have so few out-stations that come under the conditions of Question 32 that a definite policy has not been laid down. In the circumstances described however a rail inspection car or motor vehicle would be utilised.	Not applicable.
Do you think that economies would result in this way by avoiding journeys between station and repair workshop ?		

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
No.	Yes.	—
—	Existing vehicles.	—
Yes.	Yes.	—
Stock in reserve.	10 % spares.	—
heavy stock previously steam hauled.	—	—
solution seems the most economical.	—	—
No.	No.	—
--	No.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAY*
INSTALLATIONS		
50. *From the aspect of the general arrangements of installations, how do you organise stores, including fuel — lubricating oil — water — sand; also, inspection and repair of diesel locomotives?*	No permanent installations have yet been completed. Suitable repair pits and the necessary machinery and accommodation are being provided. When they are built the general procedure will be for the main stores to stock component parts and despatch to Motive Power Depots to keep the small stock held at the depots at a reasonable level to meet running repairs' requirements. Fuel oil is supplied direct from the Oil Companies to sheds and put into storage tanks. At present lubricating oils are supplied in barrels to the sheds.	*Fuel Oil.* — Purchased by tender through Govern ment Stores Control Board and supplied to depo in rail or road tankers. About 7-10 days' require ments on hand in two tanks which normall operate in parallel but with arrangements so tha one can be emptied for cleaning when necessary *Lubricating Oil.* — At present supplied in drum but later will probably have to be handled in bul Delivery will most likely be by road tanker. *Sand.* — At present using facilities at steam depot Question as it affects new diesel depots to be bui has not yet been settled. *Inspection and Repair of Diesel Locomotives.* — This is not properly organised yet.
51. *What arrangements have you adopted in your installations for storing and distributing large quantities of diesel oil, size of stores in relation to daily consumption, handling methods, purification process, system of distribution?* *In the instance cited under Question 32, how do you organise supply, stocks and distribution of fuel?*	No large installations yet built but size in relation to daily consumption, plus settling (purification of the oil) will be taken into consideration. Compressed air or mechanical pump (motor driven) will be used for delivering oil to storage tanks and units. The piping system will contain suitable filters. Rail car tanks will be used to deliver the oil from the Oil Companies' installations to the storage tanks at Motive Power Depots.	In time we will probably install our own bul installations to realise the economies accruin from the purchase of fuel oil in tanker lots. Fro the holding tanks the fuel oil is purified in centrifuge and pumped into an elevated tan whence it is supplied to the locomotives. Sufficien fuel is held in the elevated tank to cover one day requirements so that power cuts or failures wi not cause difficulties. At distant stations where a single shunter located, fuel and lubricating oil is supplied i drum lots.
52. *Do you consider it necessary to provide cover for diesel locomotives and to heat sheds provided for their protection? What method do you use? Has it proved satisfactory? What alterations have you in mind?*	When Diesel locomotives are brought to the depot for servicing or maintenance examination it is very desirable that they should be repaired under cover. No heating for protection is considered necessary owing to moderate climatic conditions in Great Britain. This is considered satisfactory. Stabled in the open after examination and servicing. The workshops for motive power maintenance will be heated for the comfort of staff.	It is considered most desirable that the diese should be stabled under cover. The sheds are heated for the comfort of staff an not to protect the diesels. Anti-freeze is used in certain localities and places subject to hard winters electric immersio heaters to prevent freezing of the radiator wate as well.
53. *Do you have, or do you intend having, any special installations for the maintenance of diesel locomotives, or do you consider that the installations made available by the withdrawal of steam traction will suffice?*	The maintenance installations available at steam locomotive depots are unsuitable for maintenance of diesel locomotives. At present, diesel locomotives are stabled at steam depots, which is not satisfactory. We have in mind either new sheds which will accommodate diesel and/or electric locomotives, or where convenient, existing Motive Power Depots will be converted by dividing the shed.	Special diesel maintenance and repair sheds a being built, or existing rail car depots enlarge Major locomotive overhauls will be carried out the principal locomotive workshop in each Islan but otherwise the diesels will not go to existi workshops.

CEYLON GOVERNMENT RAILWAYS	JAPAN	U.S.A. ASSOCIATION OF AMERICAN RAILROADS
e are made available at the mainten- depots.	Have installed fuel oil tanks, oil feeding system, battery recharging device, engine dismounting device at a part of the existing engine shed allocated for stabling of diesels.	Stocks of spare parts, fuel, lubricating oil and sand are under the supervision of the Stores Department and it is their duty to keep adequate stocks in hand. If the Motive Power Department anticipates any excessive requirements for certain materials such information is furnished to the Stores Department to enable them to cover this demand. The maintenance of adequate water supply and equipment usually is under the Engineering Division. Inspection and repairs of diesel locomotives is under the jurisdiction of the Motive Power Department.
el fuel is stored in storage tanks. ient filtration is provided and fuel- of locomotives is done through r pumps and fuelling guns. Stocks ed and frequency of replenishment at different depots.	Underground storage tanks and suitable storage for oil drums have been installed to hold sufficient supplies for one week's use. Supplies in bulk received direct from the Oil Company or JNR main stores. Either a stand or a simple oil supply apparatus is used. For purification, a centrifugal separator is used. As a rule, distribution is carried out by means of tank car.	Storage capacities for fuel oils and lubricating oils vary with the number of locomotives maintained and serviced at the terminal. The storage capacity does not depend entirely on daily usage but rather on the price of this material. When the price of fuel and lubricating oil is down the storage facilities are kept full and allowed to reduce to a lower figure when the price is up. Oil supplies are pumped into storage tanks and pumped out of tanks to the various using points. Usually, it is filtered when placed into storage tanks and as it is used. At small outside points a small stock of essential parts is maintained and locomotives are fuelled in some instances from highway tank trucks and in some instances a railway tank car equipped with either an electrically or air operated delivery pump is sent to the small terminal. The air operated pump can be operated by the locomotive if necessary.
el locomotives are garaged under r. No heating of shed is necessary.	Not required in Japan.	It is desirable to provide heated buildings to house the locomotives. If they are not put under cover it is necessary to drain the water system or keep the engine running. The decision as to what installations to provide would depend on the size of the terminal and number of locomotives assigned.
pecial diesel locomotive shed with ern facilities for maintenance has planned.	Consider that the installations made available by the withdrawal of steam traction will suffice, if some special installations such as shown under Question 50 are supplied.	Installations used for the maintenance of steam power are not entirely satisfactory for diesel maintenance. Some of the small terminals are adaptable to maintenance of both steam and diesel locomotives. It has been the practice to provide new installations at the large terminals especially where heavy overhaul work is performed.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
INSTALLATIONS		
50. *From the aspect of the general arrangements of installations, how do you organise stores, including fuel — lubricating oil — water — sand; also, inspection and repair of diesel locomotives?*	Plans have been drawn up to convert existing buildings at Mombasa into a diesel repair shop. Our main concentration of diesel and road vehicles will eventually be there and the repair arrangements will allow the machining facilities to be pooled for their joint use. It is the intention to fuel the locomotives on a siding outside the repair depot, and as their fuel tank capacity lasts them through more than their normal duration in traffic, one fuelling point should be sufficient. Sand and water supplies will be kept outside the depot repair shop to avoid contamination of dismantled locomotives. For the inspection of locomotives the main repair shop will be equipped with a 10-ton overhead crane and pit with adjacent spare part stores. A separate shop will be built with a drop pit for overhauls.	In the Diesel Shed under construction a running shed section is being provided fo routine inspections on a worhshop basis fo major overhauls. A machine shop is als being provided.
51. *What arrangements have you adopted in your installations for storing and distributing large quantities of diesel oil, size of stores in relation to daily consumption, handling methods, purification process, system of distribution?* *In the instance cited under Question 32, how do you organise supply, stocks and distribution of fuel?*	The planned arrangement at Mombasa allows for two underground service tanks of 4 000 glns. each with two electrically driven pumps with hand operated fittings in case of a power breakdown, each capable of delivering 20 gallons per minute with connections so arranged that either or both pumps would draw from either tank. The draw off of oil will be indicated in gallons on a clock dial or similar automatic indicator. These tanks will be sited so that they can be gravity filled from the railway tank wagon. The tanks will be complete with suction strainer, outlet filters, gauges, ventilators, manholes and with provision for sludge settlement and drain-off.	—
52. *Do you consider it necessary to provide cover for diesel locomotives and to heat sheds provided for their protection? What method do you use? Has it proved satisfactory? What alterations have you in mind?*	East African conditions require that the diesel locomotives be housed against torrential rain damage when under repair and some protection against the heat must be given to the employees whilst working on the locomotives. At the moment the diesel locomotives out of service are housed in the steam locomotive depots.	It is considered necessary in tropical cli mates to provide cover for diesel locomo tives whilst they are being serviced owin to the large quantities of dust which ar present during the dry season. Heating problems of sheds does not arise
53. *Do you have, or do you intend having, any special installations for the maintenance of diesel locomotives, or do you consider that the installations made available by the withdrawal of steam traction will suffice?*	't is the intention to build a separate depot at Mombasa for diesel maintenance, so that their repair may be entirely divorced from the dirt and dust usually associated with steam locomotives. In other depots where the sheds are used jointly by steam ocomotives and diesels, a definite portion of the shed will be set aside for diesel repair.	A complete new installation is being bui for the maintenance of diesel engines, th to include Running Shed facilities, Machin Shop and Electrical and Mechanical Ove haul facilities.

NORWAY	REPUBLIC OF IRELAND	NEW SOUTH WALES
ing and inspection are undertaken in previous steam locomotive depots.	Stores including fuel and lubricating oils are held at the depots where examinations are carried out. See replies to Questions 40 and 51.	—
nbustion fuel stocks for six months use. furnishers are also engaging to keep a ain quantity.	The following are the particulars of the fuel depots :— 2 major depots each consisting of 2 vertical storage tanks of 500 tons each. 3 depots each containing 4 tanks of 12 000 gallons. 3 depots each containing 1 tank of 12 000 gallons. 11 depots each containing 1 or more tanks of total capacity of 5 000 gallons or less. Diesel oil is distributed in rail tank wagons. The average stock of outlying stores is approximately 4 weeks consumption but those nearer the main stores are less; the total storage capacity is approximately six weeks' consumption. At each depot, pump house and pumping facilities are provided as well as filtering and settling tanks, oil being piped to service points for locomotive fuelling, and railcar loading and unloading.	—
, the diesel locomotives ought to be tered after completing their runs during winter because of severe frost.	No.	—
installations made available by the drawal of steam traction will suffice some changes and additions.	Special installation by modification and reconstruction of steam shed facilities.	—

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWAYS*
54. *What arrangements do you think should be introduced into workshops and sheds for the dispersal of exhaust gas?*	It is only considered necessary that a duct from the roof to the engine's exhaust is essential where engines are being tested after repairs.	Extraction fans will be provided.
ECONOMY INVESTIGATION		
55. *What are the reasons which lead you to substitute diesel traction for steam traction? Amongst these reasons, which are those of essentially economic consideration?*	With diesel locomotives there should be greater availability than with steam. Coupled with this, the increasing cost of coal and the diminution of suitable supplies must be considered. In spite of the greater capital cost of the diesel, it is expected that with the increased availability this should produce economies. Sufficient knowledge has not been gained for main-line diesels. With diesel shunters economies have been achieved.	The North Island Main Trunk line is reaching traffic saturation. It is ultimately intended to electrify this line but pending electrification the capacity of the line requires enlarging as quickly as possible. Having regard to relative economics, availability of enginemen, skilled workmen in all categories, capacity of tracks, signals, crossing places and other facilities, it has been decided, as an interim measure to operate this section with diesel-electric locomotives.
57. *Have you effected any economies that you did not foresee? Has the introduction of diesel traction given rise to extra expenses? What are they?*	No. Yes, extra expenses have been incurred in the building of diesel sheds and installations.	—
58. *Has dieselisation, by enabling you to offer better services, increased receipts because of improvements in the quality of the service? Can you give a percentage indication of this increase in receipts?*	At places where steam services have been replaced by diesel multiple unit trains (diesel rail cars) the receipts have shown increases up to 66 %.	The substitution of rail cars for steam passenger trains during the next two years is expected to increase receipts considerably by reason of the faster and cleaner services possible under rail car operation. Faster transit of goods will be obtained when goods services are dieselised and this will tend to maintain receipts at a somewhat higher level than would otherwise be the case.
59. *Does it appear to you that the substitution of diesel for steam traction is likely to result in a considerable decrease in the risk of fires alongside the track? If so, can you give any statistics to indicate this advantage?*	It is considered that by utilising diesel locomotives there is a reduction in lineside fires. No statistics available owing to the present limited number of diesel units.	There has been insufficient experience in the use of diesels to result in any marked influence as yet, on the incidence of lineside fires, and no statistics are available. When coal burning locomotives are completely eliminated from a section the main risk of lineside fires will be removed.
60. *Does it appear to you that the substitution of diesel for steam traction is likely to lead to economy in track maintenance? What is your percentage estimate to this saving?*	Unable to state as we have insufficient experience at the moment.	Diesels can be designed so as to ensure marked economy in track maintenance. In developments to date of diesel types, the Bo-Bo, Co-Co and A1A types appear to predominate over others in which guiding bogies are incorporated. This is due to consideration of locomotive performance and maintenance which must be considered along with the tracking characteristics of the locomotive. If guiding bogies are eliminated, this should be compensated for in every way possible by strict attention to all features of running gear that may affect tracking, e.g. vertical and lateral shock absorption and axleload equalisation, together with adherence to the principle of distributing the adhesive load over many light axles rather than few heavy axles, ensuring that the disposition of axleloads is such as to minimise rail stress.

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
will have due consideration when ning the new shed referred to under tion 53 above.	We think chimney or exhauster fan, or both should be introduced.	In workshops or sheds where it is necessary to run the diesel engine in connection with the maintenance work overhead hoods equipped with exhaust fans should be provided.
main factors are :— Economy. er percentage of availability has eved economy expected.	Fuel cost is half as much as that for steam traction. The running per locomotive, per day, is longer in the case of diesel traction than steam. The problem of smoke nuisance can be solved by dieselisation. The first two items are of essential economic consideration and have enabled us to achieve the expected economy in running; no data available for maintenance.	Characteristics of diesel traction permitting more efficient operation and eliminating Helper Service on many grades which was necessary when steam locomotives were used, and the change-over has achieved all the economy expected.
No. for special facilities and to a certain nt on duplication of work necessary ng transitional period from steam to l.	No. Expenses for the special installations as cited in our answer to Question 50 are our only extra expenses caused by the introduction of diesel traction.	No unforeseen economies were evident nor were any extra expenses encountered.
certain extent, but figures cannot rnished.	Due to the very limited number of diesels in service, no distinct indication of increased receipts has been shown.	Better service was provided with diesels because of maintaining higher average speeds because of eliminating service stops of steam locomotives and the drawbar characteristics of the diesel locomotive are superior to the steam locomotive.
Yes, statistics not available.	It is true that the risk of fire alongside the track will be considerably decreased, but we have no statistics to justify it.	Fires alongside the railway were not generally caused by steam locomotives unless there were defects in the smokebox arrangements. This was never a serious problem and we have no statistics to present.
Yes.	Yes, it appears to us that the substitution of diesel for steam traction is likely to lead to economy in track maintenance, but not much can be expected by this.	Yes, especially on curves.
No statistics available.		No estimate of savings available.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
54. *What arrangements do you think should be introduced into workshops and sheds for the dispersal of exhaust gas?*	The steam locomotive shed is normally sufficiently well ventilated to give adequate dispersal of exhaust gases, and as heating the sheds is not a problem in East Africa, adequate circulation is ensured by the normal procedure of leaving the end doors of the repair depot open.	Where there is sufficient headroom an natural ventilation as there will be in th diesel shed described in (53) special arrange ments are not considered necessary for th removal of diesel exhaust fumes. Th main exception is of course where th power equipment of diesel electric locomo tives is being tested, under cover, afte overhaul when provision should be mad for exhaust fume removal.
ECONOMY INVESTIGATION		
55. *What are the reasons which lead you to substitute diesel traction for steam traction? Amongst these reasons, which are those of essentially economic consideration?*	At no depot or yard have we completely substituted steam for diesel locomotives, though this is to be the eventual policy. One of the main reasons for the changeover to diesel locomotives is their operational availability, and it has been shown that this, and their overall suitability for shunting, can give a marked increase in yard handling capacity, at our coastal yards. Fuel oil railage is considerably less, and certain footplate staff economies have been possible.	The prime reason for the substitution o diesel traction for steam traction was th difficulty in obtaining sufficient water fo steam locomotives during the dry seaso in Northern Nigeria.
57. *Have you effected any economies that you did not foresee? Has the introduction of diesel traction given rise to extra expenses? What are they?*	It is not possible to segregate from the present statistics expenses which would have arisen, other than those in Question 55, had the diesels not been introduced.	Not known.
58. *Has dieselisation, by enabling you to offer better services, increased receipts because of improvements in the quality of the service? Can you give a percentage indication of this increase in receipts?*	The answer to this question is not assessable, other than in the increased traffic uplift that was made possible by diesel power introduction.	—
59. *Does it appear to you that the substitution of diesel for steam traction is likely to result in a considerable decrease in the risk of fires alongside the track? If so, can you give any statistics to indicate this advantage?*	We have on East African Railways and Harbours for some time now used heavy crude oil to fire our steam locomotives, and with this method the risk of lineside fires is negligible, therefore, no improvement is expected in this respect.	—
60. *Does it appear to you that the substitution of diesel for steam traction is likely to lead to economy in track maintenance? What is your percentage estimate to this saving?*	Our calculations show that a higher axle load is possible with diesel hydraulic locomotive with jackshaft drive than with steam locomotives for the same track and sleeper stress. I have no information regarding the percentage saving likely for track maintenance as again, this depends on axle load and spacing of the locomotives substituted, their operational speed, and the traffic intensity.	—

NORWAY	REPUBLIC OF IRELAND	NEW SOUTH WALES
e workshops, the engines shall not be therefore, evacuation of exhaust gases t necessary. In the sheds, special out-nstallations have to be arranged for.	No experience.	—
per in service. e reliable train service. er comfort. el traction is cheaper in saving of fuel, and maintenance.	Financial, due to increased cost of coal and age of locomotives.	—
Not known.	Not known.	—
—	Yes, but a percentage indication of any increase in receipts is not available.	—
considered likely that the risk of fire onsiderably decreased by diesel traction. cannot give any figures.	Yes, but have not yet information.	—
Cannot be answered now.	Yes.	—
	Not yet known.	

QUESTION	*BRITISH RAILWAYS*	*NEW ZEALAND GOVERNMENT RAILWA*
63. *In the substitution of diesel for steam traction, what is your percentage estimate of resultant economies :*	Insufficient data available.	
— for train haulage service ?		For main line locomotives of roughly comparab power costs based on current fuel and other price equipment capital costs, and relative annual mil ages were recently taken out.
		Costs per Engine Mile (pence) / *Ratio of relative costs*
		Single unit 1 500 H.P. diesel electric . . . . . 79.9 / 100
		Steam locomotive burning native sub-bituminous coal 104.9 / 131.2
		Steam locomotive burning fuel oil . . . . . 116.1 / 144.2
		Steam locomotive burning native bituminous coal . . 128.9 / 161.5
— for shunting service ?		No statistical data available.
and for each of the following:		Estimated saving on using diesel mechanical instea of steam in 1950 was £20 per day. Relative fir costs, interest and depreciation were not take into account.
		Pence per Mile / *Ratio of relative costs*
— fuel (calculation to be made with and without special motor fuel taxes payable by the railway).		1 500 H.P. single unit diesel electric . . . . . 17.5 / 100
		Steam locomotive burning sub-bituminous coal . . 40.7 / 233
		Steam locomotive burning fuel oil . . . . . 51.5 / 294
		Steam locomotive burning bituminous coal . . . . 64.7 / 370
— locomotive crews.		Economies in the use of engine crews are mor difficult to estimate. As double manning of diese electrics on main lines is the rule on this railwa such savings as are made derive not from th ability to operate this power with only one ma but through the reduction of depot servicing ma hours due to the ability of diesels to make lon runs without sub-terminal engine changes. Th consequential staff economy is assessed at abou 20 %.
		Diesels work in pairs in multiple over difficu mountain areas with only one man; saving o these sections 50 % manpower.
— maintenance and repair of rolling stock (labour and material separately).		Economies in maintenance and repair cannot b stated as no diesels have yet required overhaul

CEYLON GOVERNMENT RAILWAYS	*JAPAN*	*U.S.A. ASSOCIATION OF AMERICAN RAILROADS*
dieselisation has not been completed, difficult to assess economies in this ect-figures are not available.	—	No exact figures available. Savings range from 20 to 40 %.

QUESTION	*EAST AFRICAN RAILWAYS*	*NIGERIAN RAILWAYS*
63. *In the substitution of diesel for steam traction, what is your percentage estimate of resultant economies :* *— for train haulage service ?* *— for shunting service ?* *and for each of the following:* *— fuel (calculation to be made with and without special motor fuel taxes payable by the railway).* *— locomotive crews.* *— maintenance and repair of rolling stock (labour and material separately).*	—	—

NORWAY	*REPUBLIC OF IRELAND*	*NEW SOUTH WALES*
	Not yet known.	—
Train hauling service — 30 %.		
Shunting service — 25 %.		
Fuel (there are no special fuel taxes).		
Locomotive crews — 40 %.		
Maintenance — 50 %.		

M. WEISSENBRUCH & Co. Ltd.
Printer to the King

(Manag. Dir.: P. de Weissenbruch,
238, chaussée de Vleurgat, XL)

PRINTED IN BELGIUM

Edit. responsible : P. Ghilain